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FLEXIBLE COVERING SYSTEM AND CORRESPONDING MODULES FOR  
WALLS, CEILINGS AND OTHER BOUNDARIES

5 TECHNICAL FIELD

The present invention relates to flexible systems for covering walls, ceilings, etc., including also movable partitions for subdividing a room, said system comprising a plurality of modules which can be attached in a releasable manner to attachment  
10 structures on said walls, ceilings, etc. and furthermore to modules for such systems, where the dimensions and physical properties, specifically - but not exclusively - the acoustic attenuation and/or reflection properties of the modules can be selected according to the specific requirements.

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BACKGROUND OF THE INVENTION

Various panels for covering walls or ceilings are well known within the art and especially panels made of wood have been known for centuries. Often such panels  
20 have primarily served decorative purposes but panels hung from the ceiling to cover technical installations such as electrical installations or air conditioning systems have been widely used for decades. Often such panels are provided with acoustical damping properties, thereby making it possible to alter the acoustic characteristics of the room in which they are applied. Panels of the latter kind are often designed as  
25 a rectangular or square plate of relatively limited thickness provided with a pattern of openings through the panel to provide access to the space behind the panel and the wall- or ceiling structure. This space is often additionally partly filled with a sound-absorbing material.

30 Although often used indoors, such panels may also be used for outdoor applications. Panels specifically designed for this purpose are for instance disclosed in JP 4118407, describing panels of a rectangular shape to be fitted to boundaries for instance located along motorways, etc. These panels comprise a rectangular sound-insulating plate bounded by a frame structure, which can be shaped to allow  
35 the panels to be fitted on a curved boundary.

A few examples of panels for indoor applications are found in US 5,214,891 and US 3,789,747. Thus, US 5,214,891 discloses a kind of panel-like structure, the dimensions of which can easily be adapted to the specific application. The "panel" itself consists of a flexible and resilient sheet of plastics or cloth suspended in a frame structure fixed to a wall, where the frame is provided with fastening means gripping the sheet and straightening it out to form a substantially planar front face of the sheet of resilient material. The material of the sheet can be chosen according to its sound-absorbing and/or fire-resistant properties.

US 3,789,747 discloses a prefabricated structural wall panel for modular construction of soundproof enclosures. The panels of this structure, which are of a generally rectangular shape with relatively limited thickness, are hollow boxes filled with an acoustic damping material and internally provided with a ventilation channel connected to an air intake and an air outlet for ventilating purposes.

Although adaptation to a curved surface has been addressed in the above mentioned JP 4118407, the panels generally available are of predetermined dimensions often making it difficult - if not impossible - to adapt these panels to various curved surfaces and still preserve the shape of the surface itself. Thus, it would be beneficial to provide a system of covering modules for walls, ceilings and other boundaries which can more easily be adapted to the various surfaces of rooms, etc. Furthermore, it would be beneficial to provide covering modules, the acoustic characteristics of which can be chosen according to a specific need and which modules can be assembled into flexible covering systems not only covering a surface by a single layer of modules but also with more complicated multilayer structures, which can lead to a further optimisation of for instance acoustical properties of the covering system. These and other advantageous effects are provided by the covering modules and corresponding systems according to the present invention.

#### DISCLOSURE OF THE INVENTION

According to the preceding background it is an object of the present invention to provide a flexible covering system for walls, ceilings and other boundaries that can be adapted to both planar and curved surfaces. An example of such surfaces would be the interior surfaces of a room, for instance walls, ceilings or partitions, but the invention is not limited to these specific applications.

It is a further object of the present invention to provide a system of the above kind having acoustical properties that can be adapted to specific requirements at the site of application of the system.

It is a further object of the present invention to provide a system of the above kind that allows a flow of air through at least chosen portions of the system for instance for air conditioning purposes.

It is a further object of the present invention to provide suitable modules for assembling said flexible covering system. The requirement of flexibility implies not only that the modules should be of such a form that the system can be adapted to both planar and curved surfaces as mentioned above, but also that a mixture of different modules can be used to build up a given system and that the modules, although reliably fixed to the surface in question, can be easily removed and replaced by other modules of the same or a different size or properties.

These and other objects are attained according to the invention by a module according to independent claim 1 and a system according to independent claim 24. Various advantageous embodiments of modules and systems according to the invention are defined in the dependent claims.

In the following, the covering modules and -systems will generally be referred to as "wall-covering" modules and systems, this being at present regarded as the main application for these modules and systems, but it is understood that the modules and systems as mentioned can be used for covering other surfaces as well.

According to the invention, as defined in independent claim 1, there is thus provided a wall-covering module, which according to preferred embodiments of the invention

- is of elongated shape, although the invention is not limited to this shape, said module comprising a front face, which can be planar, curved, corrugated etc., on at least two opposite sides hereof bounded by edge portions for connecting the module to one or more attachment portions for attachment to a corresponding structure on for instance a wall, etc., where each of said edge portions comprises a lateral portion extending at an angle  $\alpha$  relative to the front face. The front face can have a smooth surface, but it can also be provided with structural details, for instance affecting sound radiation from the front face.
- 10 In the various embodiments described in the following said attachment structure on for instance a wall is a plurality of substantially parallel rails, but it is understood that equivalent means could also be used, provided they fulfil the requirements relating to the flexibility of the system as described in more detail in the following.
- 15 The modules according to the invention can either be made as a solid block of material, for instance aluminium or wood or a body of sound-absorbing material comprising said front face and edge portions and being of sufficient thickness in order to – in combination with the material used and its structure or porosity - provide the sound-absorbing characteristics desired - but they can also take the
- 20 shape of a hollow, either closed or partly open, body comprising said front face, edge portions and an optional rear wall, in the latter case providing an internal cavity within the module, a cavity which can be closed at either longitudinal end of the module, if desired. Providing the module with this internal cavity offers the possibility to provide the module with various desirable acoustical attenuation properties, as
- 25 will be described in detail in the detailed description of the invention. In the following modules of the latter, i.e. hollow kind, will generally be referred to as modules of the first kind, whereas modules of above-mentioned kind consisting of a solid block of material will be generally referred to as modules of the second kind.
- 30 The angle  $\alpha$  between the front face and said lateral portions can according to the invention be chosen corresponding to the specific requirements when the modules are used to assemble a complete wall-covering system comprising a plurality of modules placed adjacent each other. Thus, by proper choice of  $\alpha$ , a plurality of adjacent modules according to the invention can be adapted to a curved surface as
- 35 described in detail in the detailed description of the invention.

5 The front face of the modules can be left uncovered, but it is also possible to cover the front face by for instance a fabric, both for aesthetic purposes and in order to influence the sound absorbing and/or reflecting properties of the front face. This fabric can be wrapped around the front face and the edge portions, these edge portions in this case being provided with appropriate fastening means making it possible to remove the fabric for replacement. Alternatively, the front face of the module could be provided with veneer or a tape attached to the front face, e.g. by an adhesive.

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The wall-covering modules of the first kind according to the invention can be made as one piece comprising for instance said front face, edge portions and rear wall surrounding said cavity, but according to an alternative embodiment the modules can alternatively comprise separate edge portions, which can be attached to a separate front face, for instance by means of an adhesive, thus making it possible to devise modules of individually chosen dimensions corresponding to specific requirements at the site of application. Different front faces can also be used, some of the modules for instance comprising front faces of the kind described above covered by a fabric and other front faces having different coverings or even being adapted to quite different purposes. It is thus within the scope of the invention to use front faces for instance in the form of monitor screens, loudspeakers, panels for electrical connectors etc. Furthermore, as the modules according to this embodiment comprise separate edge portions – provided with separate attachment means – the width of the module may also be altered, if necessary, without making major changes of the attachment structure behind the modules necessary. This attachment structure will be described in more detail below.

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30 The modules according to the invention can either be bounded along two opposite edges of the front face by said edge portions, but the modules can also be bounded by such edge portions along all four edges of the module, the edge portions thus constituting a frame-like structure surrounding the front face and optional rear wall. Both of these possibilities will be shown and described in the detailed description of the invention.

Various embodiments and constructive details of the modules according to the invention are described in the detailed description of the invention, and defined by the dependent claims 2 to 23.

- 5 A flexible wall-covering system according to the invention, as defined by independent claim 24, comprises in its most basic form a plurality of rails or equivalent fastening means for attachment to a wall structure, a ceiling or the like, where said system comprises a number N of planes P1, P2 .... at predetermined distances from said wall structure, where  $N = 1, 2, \dots$ , where P1 corresponds to the  
10 plane at the greatest distance from the wall structure, and where the attachment portions of said modules can be brought into releasable engagement with said rails at any desired position along the rails.

- 15 If the shape of the outer surface of the modules lying in plane P1 furthest away from the wall structure is to resemble the shape of the wall structure itself, the planes will be running substantially parallel to the wall structure, but the various planes P1, P2 .... may also extend at other angles relative to the wall structure if desired. This possibility could for instance be utilised for designing acoustically reflective surfaces for improvement of the acoustics of a room.

- 20 In the above, there has specifically been referred to "rails" for attachment to a wall structure or the like, but it is understood that the term "rail" should be construed in a broad sense, thus comprising any elongated means allowing displacement of the attachment portions of the modules along these.

- 25 In a flexible wall-covering system according to a specific embodiment of the invention and defined in claim 26, two substantially parallel planes of modules are used, i.e.  $N = 2$ , the first of these planes, i.e. the outermost plane, containing modules of the first kind and the second of these planes, i.e. the plane closest to the  
30 wall structure, containing modules of the second kind according to appended claim 5 and specifically comprising a body of sound-absorbing material. Furthermore, according to this specific embodiment, passages are provided between adjacent modules of the first kind in the outer plane to provide access to the space behind this plane and thereby to the modules of the second kind provided in the second  
35 plane in this space. These regions and the modules placed herein serve various

purposes, among which specifically acoustical treatment of the room in which the system of modules is applied should be mentioned. The purposes may serve air-conditioning/heating purposes, and light sources could also be placed behind the first plane of modules for illumination of the room or for decorative purposes.

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Although, according to the above embodiment of a wall-covering system according to the invention, specifically modules of the first kind are used in the first, i.e. outermost plane and modules of the second kind are used in the second plane between the first plane and the wall structure, it is understood that in principle  
10 modules of both the first and the second kind could be used in any plane in a wall-covering system according to the invention.

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Although not specifically so limited, a flexible wall-covering system according to the invention may comprise intermediate attachment members, which can be displaced  
15 along said rails, so that the distance between adjacent intermediate members can be chosen according to the width of the module in question. The intermediate attachment members are formed for releasable engagement with attachment portions provided on each of the individual modules. Typically two rails will be required for each of the modules, but more rails could of course be used, for  
20 instance in case of exceptionally large modules. By providing the system with intermediate attachment members, which can be displaced along the rails, and with releasable engagement between these intermediate members and the corresponding attachment portions on the modules, a high degree of flexibility of the wall-covering system according to the invention is attained.

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According to the invention, an alternative attachment means of the modules comprises a fastening member adapted for releasable engagement with rear portions of the corresponding module, which fastening member can be attached to the rail at predetermined locations hereon for instance by means of a screw. The  
30 rails can either be provided with a pattern of holes for passing of said screw at specific intervals along the rails or holes can be drilled at those locations along the rails, where the fastening members are to be placed. Attachment means of this type will also be described in detail in the following.

Generally, modules in the different planes – or their attachment portions – are displaced relative to each other in the direction of the rails, whereby it becomes possible to pass the attachment portions of modules placed at greater distances from the wall structure through passages provided between adjacent modules in planes closer to the wall structure. The attachment portions of an outer module may either fill the complete passage between adjacent modules closer to the wall structure or at least one passage may be provided between said attachment portions and the passage through which it passes, thereby allowing a flow of air to take place through the different planes of modules of the system. In this manner, it becomes possible to provide channels for flow of air for air-conditioning of rooms, etc., covered by the modules according to the invention, and noise from air conditioning equipment can be attenuated by proper choice of acoustical properties and dimensions of modules making up these channels. Furthermore, no matter whether such channels for flow of air are in fact provided or not, passages between the edge portions of the modules in the first – outermost – plane to regions behind this plane, which regions may comprise a second layer of modules with sound-attenuating properties, can be used to influence the overall sound treatment of the room attained by the wall-covering system according to the invention, as will be described in more detail in the detailed description of the invention.

The wall-covering modules according to the invention can be used to cover walls, ceilings, etc. of for instance a room, thereby serving both aesthetic purposes and also as mentioned acoustical purposes. It is, however, also possible to provide movable partitions for flexible subdivision of a room into separate compartments for instance in offices, libraries, etc., with systems of the modules according to the invention, thereby for instance creating subspaces in the room with relatively high acoustical damping. Furthermore, by proper choice of the orientation of the outer plane (P1) of a system of modules according to the invention (the rails for attachment of the modules to a wall structure may not necessarily run parallel to the wall structure behind the module), sound reflections from portions of the walls or ceiling may be modified by systems of modules according to the invention.

A large variety of materials can be used for the modules according to the invention. Thus, the modules can be made of various metals such as aluminium (for instance anodized), stainless steel, copper, etc., or the modules can be made from suitable

plastics materials, composites, wood, marble, glass, MDF, etc. The surface of the modules can be left un-covered, but they can also be covered by a fabric, as described in detail in the following, veneer or other coatings. The above list is by no means meant to be exhaustive. Furthermore, the part of the modules comprising the front face could be made of plasterboard.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail with reference to the accompanying drawings, in which:

Figure 1 shows a schematic perspective view of two embodiments of the wall-covering modules according to the invention and their connection to for instance a wall;

Figure 2 is a cross-sectional view corresponding to Figure 1;

Figure 3 is a cross-sectional view of a third embodiment of a wall-covering module according to the invention;

Figure 4 is a cross-sectional view of a fourth embodiment of a wall-covering module according to the invention;

Figure 5 is a cross-sectional view of a fifth embodiment of a wall-covering module according to the invention;

Figure 6 is a cross-sectional view of a sixth embodiment of a wall-covering module according to the invention;

Figure 7 is a cross-sectional view of a seventh embodiment of a module according to the invention and a specific embodiment of attachment means for releasable engagement with rear portions of the module;

Figure 8 is a perspective view of a seventh embodiment of a wall-covering module according to the invention employing the attachment means shown in Figure 7 and provided with a frame-like structure of edge portions;

- 5 Figure 9 is a perspective view of a part of an eighth embodiment of a wall-covering module according to the invention employing the attachment means shown in Figure 7 and provided with a frame-like structure of edge portions;

Figure 10 is a detail of the edge portions of a module shown in Figure 9;

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Figure 11 is a cross-sectional view of a detail of a wall covering system comprising modules according to the invention, where no passage is provided between adjacent modules;

- 15 Figure 12 is a cross-sectional view of a detail of a wall-covering system comprising modules according to the invention, where a passage is provided between adjacent modules to allow sound wave access to the cavity defined by adjacent modules and the wall structure behind the modules;

- 20 Figure 13 is a cross-sectional view of a detail of a wall-covering system comprising modules according to the invention, where a passage is provided between adjacent modules with the dual purpose of providing sound wave access as in Figure 6 and also to allow a flow of air for air-conditioning purposes;

- 25 Figure 14 is a perspective view of a practical implementation of a part of a wall-covering system as described in Figure 13 comprising modules of the first and third embodiment according to the invention;

- 30 Figures 15A and B are examples of the flexibility attained by the modules according to the invention.

Figures 16 A and B illustrate the possibility to use gaps between the modules for the attachment of shelves, etc.;

Figure 17 illustrates the possibility to utilise a portion of the cavity in a module to accommodate electrical cables, etc.;

5 Figure 18 illustrates the possibility to provide the front face of a module with an electrical switch;

Figure 19 illustrates the presence of a loudspeaker in the second plane of a system of modules according to the invention;

10 Figure 20 illustrates the possibility to form a module as a sound-radiating device such as a loudspeaker;

Figures 21 A and B illustrate the placement of a video screen in a system of modules, wherein modules of different length are used;

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Figure 22 illustrates an alternative attachment portion;

Figure 23 illustrates the attachment of a module according to the invention to a U-shaped rail by means of the alternative attachment portion shown in Figure 22; and

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Figure 24 illustrates a ninth embodiment of a covering module according to the invention.

## 25 DETAILED DESCRIPTION OF THE INVENTION

In the following, a detailed description of various embodiments of the wall-covering modules and systems comprising such modules according to the invention is given. The various systems of modules shown in the detailed description of the invention generally comprise vertically extending modules attached to horizontally extending rails, but it is understood that the invention also covers systems of horizontally extending modules attached to vertically extending rails and in fact systems with any orientation of the modules and the corresponding rails relative to the horizontal or vertical plane.

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Three different basic embodiments of modules according to the invention are shown in Figures 1, 2 and 3. Thus, with reference to Figures 1 and 2, there is shown two different embodiments of the wall-covering modules according to the invention generally referred to as 1 and 2, respectively. The modules according to the first  
5 embodiment 1 are formed as elongated hollow bodies comprising a planar front face 4, but it is understood that the front face is not necessarily limited to a planar face. Thus, for instance outwardly or inwardly arched faces could also be envisaged. The front face 4 is on either longitudinal side hereof provided with edge portions generally designated by reference numeral 5 comprising lateral portions 7 and  
10 attachment portions 8, the latter having the form of circular recesses, the function of which will be explained in the following. At the rear part of the module, i.e. opposite said front face 4 there is provided an attachment portion, generally designated by 6 and comprising a U-shaped portion 9 for releasable attachment to a corresponding intermediate attachment member 10 positioned at appropriate intervals along a  
15 horizontally extending rail 13 mounted on the wall structure 14. Due to its resiliency the U-shaped portion 9 can be inserted over the intermediate attachment member 10 and maintained in position on the intermediate attachment member 10 by engagement between an inner protrusion 11 on the U-shaped portion 9 and a corresponding groove (not shown) in the intermediate attachment member 10. It is  
20 thus possible to attach the module 1 reliably at the appropriate position on the wall structure and to detach the module again without risk of damage and without the application of tools.

Figures 1 and 2 show cross-sectional views of the modules and depict the modules  
25 as longitudinally extending bodies, which are open at the longitudinal ends hereof. In certain situations such open-ended modules may in fact be used, but the modules can also be provided with closure means at one or both longitudinal ends hereof as will be described in more detail below in connection with Figures 7 through 10. If such closure means are provided at either longitudinal end of the module 1 shown in  
30 Figure 1, this module will comprise an inner, closed cavity 19 (see Figure 2), which can be used for instance for acoustical purposes as described below.

The first embodiment 1 of a module according to the invention can be formed as one piece for instance as a metal profile. A suitable material could be aluminium, but a

number of other possible choices of material would also be obvious to a person skilled in the art. Also extruded plastic profiles could be used as a possibility.

5 A second embodiment of the wall-covering module according to the invention is shown in Figures 1 and 2 generally designated by reference numeral 2. Contrary to the one-piece module 1 described above, the second embodiment 2 comprises a separate front face 15 and two separate opposing lateral edge portions 5 of a form symmetrical with respect to a longitudinally extending plane Z through the module 2. The general layout of these edge portions 5 corresponds to the edge portions 5 on  
10 the first embodiment 1 and they are extended by attachment portions 16 formed integrally with the corresponding edge portion.

The second embodiment 2 of the wall-covering module according to the invention is well suited for modules of larger width, i.e. longer extension along the X-axis as  
15 shown in Figure 1 than the first embodiment 1. Thus, modules of larger width generally require at least two longitudinal attachments to the wall structure to attain the required mechanical stability and the single attachment 10, 11 of the first embodiment 1 would not be appropriate in this case.

20 The second embodiment 2 has the inherent advantages of providing a module which is flexible with respect to the width of the module without it being necessary to produce a range of complete modules of different width, as it would have been required in connection with the first embodiment. In fact, the second embodiment 2 basically consists of only two parts: The front face 15 and lateral edge- and  
25 attachment portions 5, 16, these portions being in fact similar and merely rotated 180 degrees relative to each other in actual use. The complete module 2 is completed by providing two of these portions 5, 16 of appropriate length from the same profile and connecting these by a front face 15 of a desired width. The connection between the edge portions 5 and the front face 15 can be accomplished  
30 by means of a suitable adhesive along corresponding longitudinal adjacent recesses 18 in the edge portions 16 and the front face 15, but it will also be possible to devise other connection means between the front face and the edge portions which provides for a releasable connection between the front face and the edge portions. In this manner it becomes easy to replace the front face if desired, either for  
35 replacement of a defective front face or for choosing a different appearance or

different acoustical properties as will be described in more detail in the following. It may even be possible to replace a simple front face, for instance solely serving decorative purposes, with more special and dedicated devices, such as monitor screens or loudspeakers. Modules initially comprising such devices provided in their front face are of course also a possibility.

Contrary to the first embodiment 1, the wall-covering module 2 according to the second embodiment does not inherently comprise a cavity 19, which can be closed at either longitudinal end. The module according to the second embodiment is in its basic form rearwards open as indicated by reference numeral 17 in Figures 1 and 2, but as indicated in Figure 2 it is possible, if desired, to provide a rearward closure panel 20 to form a closed cavity 21, which can be used for instance for acoustical purposes, as mentioned above.

Referring now to Figure 3, there is shown a module of the second kind according to the invention, i.e. a module, which does not comprise a hollow body but which instead comprises a block of material consisting either of a substantially rigid material such as wood, aluminium or a plastics material, but which can also consist of a material with suitable acoustic attenuation properties, such that modules of this kind can be used primarily for sound attenuation purposes. Thus, according to Figure 3 the module comprises a block of such material with a front face 4 and edge portions 5 comprising lateral side portions 7 forming an angle  $\alpha$  with the front face. The attachment means 6 can either be of the type forming an integral part of the module (as in Figures 1 and 2) or the module can be provided with engagement means as in Figures 3, 7, 8 and 9 for releasable attachment of the module to such attachment means.

Referring now to Figure 4, there is shown a third embodiment of the module according to the invention corresponding basically to the first embodiment 1 except for the attachment means for attachment to the wall structure. Thus, contrary to the attachment means of the first and second embodiments as shown in Figures 1 and 2, according to which the attachment means are integral parts of the modules 1 and 2, respectively, designed for releasable engagement with the intermediate attachment member 10, the modules according to the third embodiment do not comprise attachment means themselves but are instead provided with a rearward

recess 40 for insertion of laterally resilient attachment means 6' herein, whereby protrusions 11' are brought into contact with corresponding grooves 11", thus releasably connecting the module with the attachment portion 6. The attachment portion 6 is in turn connected to the rail at the appropriate location on the wall structure 14.

Attachment means of the kind shown in connection with the above third embodiment of modules according to the invention are also employed in connection with the seventh and eighth embodiments shown in Figures 7, 8 and 9, although the engagement means between the module and the attachment means is differently formed in these embodiments.

One characteristic feature of the modules according to the invention as exemplified by all the embodiments shown is the inclined extension of the lateral portions 7 relative to the front face 4 as indicated by the angle  $\alpha$ . This feature facilitates an adaptation to various curved surfaces as will be described in connection with systems comprising a plurality of the wall-covering modules as shown schematically in Figures 15A and B.

In the following, a detailed description of various embodiments of the wall-covering modules according to Figures 1 and 3 is given. The common aim of these embodiments is to devise various means of affecting the acoustical properties of for instance a room, in which the wall-covering modules are used, through introduction of sound-attenuation properties of the modules. The fact that the modules shown in Figures 1, 2 and 3 are designed such that they can form closed cavities 19 within the modules is utilised in two of these embodiments, viz. those shown in Figures 5 and 6.

Referring now to Figure 4, the front face 4, which in Figures 1 and 2 is shown as a simple planar surface, which is essentially acoustical "hard", i.e. which does not in any material degree give rise to acoustical attenuation of sound waves impinging on this surface, can be provided with a certain degree of sound attenuation by wrapping a suitable fabric 24 around the front face 4 and fastening this fabric by introducing the edges hereof into the recesses or channels 8 together with an appropriately shaped body, e.g. a cylindrical body 25 of a diameter which provides a tight fitting to

- the surface of the recesses 8. The acoustical attenuation properties can be affected by proper choice of the structure of the fabric, and acoustical attenuation of sound waves impinging on the front faces 4 can thus be achieved, especially at higher frequencies as is well known per se. It is, however, also possible to alter the acoustical attenuation characteristics of the front face 4 by the introduction of a cavity 27, herein and filling this cavity with a damping material 23, such as rubber or felt. The choice of material and also the thickness of this, i.e. the depth of the cavity 27 influence the acoustical attenuation characteristics of the front face 4.
- As mentioned above, the presence of a cavity 19 within the modules according to the first, second and third embodiments can be utilised for sound attenuation purposes. Thus, Figure 5 shows the back wall 28 of the recess 27 provided with a number of openings 29 for sound access to the cavity 19 within the module. The number, size and shapes of these openings 28 together with the volume of the cavity 19 and the presence and acoustical properties of damping material 26 within the cavity 19 affect the acoustical attenuation properties of the module. It is also possible to omit the recess 27 and/or the fabric 24 and provide the pattern of openings 29 directly in the front face 4.
- Increased acoustical attenuation at a certain predetermined frequency or within a relatively narrow frequency range comprising this frequency can be attained with the embodiment shown in Figure 6. According to this embodiment, an acoustical resonator circuit (Helmholz resonator) is formed by interaction between the volume of air contained in the cavity 19 - this volume of air acting as a compliance - and the acoustical mass of the air contained in the channel 31 connecting the front face 4 with the cavity 19. Such systems and how they are tuned to a specific attenuation frequency are well known in the art of sound treatment of e.g. lecture rooms, theatres and concert halls.
- Referring to Figures 7 and 8, there is now shown a further - seventh - embodiment of a module according to the invention together with attachment means for attaching the module to a rail 13 which is shown comprising an intermediate portion 13' running parallel with the front face 4 of the module, although other types or shapes of rails could also be envisaged. The overall shape of the module is most apparent from Figure 8, showing a perspective view of a portion of the module, the

attachment portion, generally referred to by reference numeral 6 and a portion of a rail 13.

5 The module according to the seventh embodiment is of a generally elongated shape comprising a substantially planar front face 4, lateral edge portions 7 extending at an angle  $\alpha$  relative to the front face 4 which is substantially 45 degrees, although other values of this angle could also be used. The module is furthermore provided with end portions, generally indicated by reference numeral 51 at either longitudinal end of the module, thus providing the module with the shape of a hollow body with a substantially planar front face bounded on all four edges by inwardly inclined edge portions 7, 7', said body being left open in the rearward direction, as indicated by reference numeral 52 in Figure 8. As mentioned before, it would, however, also be possible to provide the module with a rear wall 48, as indicated in Figure 7, whereby a closed cavity 19 could be formed within the module, serving the purposes as described previously in connection with the fifth and sixth embodiment of the modules according to the invention. The module is furthermore provided with a partly circular recess or channel 8 along all four edge portions 7, 7' hereof for fastening a fabric (not shown) between the inner surface of the channel 8 and a resilient fastening means of substantially cylindrical form 25 inserted into the channel 8 after the insertion of said fabric into the channel 8. Furthermore gaps 53 are provided between adjacent edge portions 7 and 7' to accommodate fabric in the corner regions of the modules.

25 Now referring to Figure 7, the attachment portion, generally designated 6 or 16 in Figures 7, 8 and 9, will be described in detail, but it is understood that a person skilled in the art would be able to conceive various modifications to these attachment means that would also fall within the scope of the present invention.

30 The attachment portion 6 comprises an essentially rigid base section formed by the side portions 41, the rear portion 42 and the front portion 43. In front of the front portion 43 there are provided laterally resilient side portions 46 adapted for releasable engagement with corresponding grooves or recesses 47 in the module. The attachment portion 6 can be mounted at the appropriate position on the rail 13 for instance by means of a screw 45 extending through the rear portion 42 of the attachment means and via a hole 44 in the intermediate portion 13' of the rail 13 to a

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back plate 50. Access to the screw 45 is obtained via an opening 49 in the front portion 43. Thus, when the attachment portion 6 has been fixed to the rail 13, the module can be pushed into engagement with the resilient side portions 46. Subsequent removal of the module from the attachment means can be affected for instance by insertion of a screwdriver or a dedicated tool between the rearward extension 8" of the module and the corresponding resilient side portion 46. It may, however, also be possible to omit the front portion 43, thus obtaining alternative attachment means as shown in Figure 22.

Referring now to Figure 9, there is shown a perspective and cross-sectional view of a portion of an eighth embodiment of a module according to the invention, in principle corresponding to the second embodiment shown in Figures 1 and 2 and described previously. The various details of the module shown in Figure 9 correspond to those of the module shown in Figures 7 and 8 except for the module according to the eighth embodiment being provided with a separate front face 4, as described in connection with the second embodiment. Furthermore, as the width of the modules according to the eighth (and second) embodiment is generally larger than that of the module according to the seventh embodiment, the attachment portion for engagement with the two opposing lateral edge portions of the modules can be split up into two attachment portions, of which only one - 16 - is shown (in cross section) in Figure 9. Otherwise, these attachment portions comprise the same details as those described in connection with Figure 7 above.

Referring to Figure 10, there is shown a corner region of a module where structural stability is enhanced by the presence of a fitting b provided in a T-shaped groove a, c.

It should be noted that the attachment portions - no matter whether they are of the type forming an integral part of the modules as shown in Figures 1 and 2, or of the type formed for releasable engagement with the modules as shown in Figures 4 through 9 - may comprise lateral edge portions 56, see Figure 1 or 14, extending in the longitudinal direction of the modules substantially throughout the length of the modules as in Figures 1 and 2, or of a longitudinal extension approximately corresponding to the height of the rail as shown in Figures 8 and 9. Although the latter option is beneficial from the point of view of saving material of the attachment

portions, the first of these options may under circumstances be desirable as it would provide for the formation of well-defined cavities behind the front faces of the modules and/or well-defined passages between adjacent modules, for instance for air-conditioning purposes. Thus, the choice between the various options depends on  
5 the actual requirements at the site of application.

A large variety of different wall-covering systems can be formed by means of the modules according to the invention shown in the preceding Figures 1 through 10. Details of such systems already appear from Figures 1 and 2, but a number of  
10 further aspects, layouts and details of such systems are furthermore shown in Figures 11 through 15 in the following. The modules actually utilised in the systems shown in Figures 11 through 15 are the modules according to the third and fourth embodiment shown in Figures 3 and 4, but it is understood that any of the  
15 embodiments of the wall-covering modules according to the invention could also have been utilised in these systems, either solely or in combinations with the other embodiments.

According to Figures 1 and 2 there is thus shown a detail of a wall-covering system made up of modules according to the first and second embodiment generally  
20 designated by reference numerals 1 and 2, the details of which have been described above. Figure 1 illustrates the possibility to build up systems of various kinds of wall-covering modules according to the invention and furthermore, the possibility to provide passages 32 between adjacent modules for instance for acoustical and/or air-conditioning purposes. Such passages could furthermore be used for passing  
25 fastening means for various objects, such as shelves etc. to be hung on the outer surface of the wall-covering system, a possibility which could for instance be useful in shops, offices, classrooms, etc., in which wall-covering systems according to the invention are used. Furthermore, in the system shown in Figure 1, attachment  
30 portions of the type comprising lateral portions 56 extending the length of the modules are used, whereby spaces bounded by these portions are formed between adjacent modules or behind a given module, which could under circumstances be beneficial if such spaces were to be used for acoustical treatment of the room or for air-conditioning purposes. It is however understood that attachment means of the  
35 kind substantially limited to the width of the rails, as shown for instance in Figures 8 and 9, could also have been used.

Furthermore, it should be noted that in systems where the attachment portions are confined substantially to the height of the corresponding rails, the width of modules in one of the above-mentioned planes  $P_i$ , may exceed the width of the modules in other planes without interfering with the attachment portions of modules in these other planes.

As shown in Figure 11, the modules can be placed along a wall surface immediately adjacent each other, i.e. without passages between the longitudinal edges of adjacent modules. Thus, a surface of modules is formed being practically unbroken except for the regions of the rounded parts 7' of the lateral portions 7.

With reference to Figure 12, there is shown a portion of a wall-covering system according to the invention comprising passages 32 providing access to regions 33 between the modules and the wall structure 14. At least a portion of this region 33 can be filled with suitable acoustical damping material 34, provided for instance as a part of the modules of the second kind described in connection with Figure 3 above, and the combined system comprising the passage 32, the region 33 and the damping material 34 can be designed to function as an acoustical attenuation means, which - depending on the dimensions and materials actually used - can be regarded as a kind of hybrid acoustical broadband attenuator and a Helmholtz resonator as described in connection with Figure 6 above. Alternatively, the region 33 may be used to accommodate sound-radiating means, for instance for radiating acoustical warning signals (smoke- or fire detectors) or loudspeakers for instance in public address systems. This possibility is especially attractive in situations where it is not desirable that such devices are visible from the region in front of the wall-covering system.

Figure 13 shows another variation of a system comprising modules according to the invention. In this case, only the central part of the region 33 between the modules and an attachment structure 37 for attachment of the modules is filled with acoustical damping material, whereby a pair of channels 35 is left for passage of a flow of air 36 for air-conditioning purposes from a region 36 between said attachment structure 37 and the wall 14 to the region 38 in front of the modules.

35

Referring to Figure 14, there is shown a perspective view of a practical implementation of a part of a wall-covering system as described in Figure 13 comprising modules of the first and third embodiment according to the invention, the modules of the first embodiment forming the outer layer (Plane 1) of the system and  
5 the modules of the third embodiment forming an inner layer (Plane 2) of the system.

Finally, Figure 15A illustrates an example of the flexibility of a wall-covering system according to the invention attained by the inclined lateral edge portions 7 of the modules. Thus, the (rounded) edge portions of the front faces 4 of adjacent modules  
10 can be placed close to each other on for instance a curved wall section or a column 55, as illustrated schematically in Figure 15A. Also adjacent modules can be placed at a corner, as shown in Figure 15B, provided the angle  $\alpha$  is chosen to be equal to or less than 45 degrees.

15 A number of detailed applications of modules and systems of modules according to the invention is finally shown in Figures 16A and B through 21 A and B.

Specifically Figures 16 A and B show the possibility to use gaps between the modules for the attachment of shelves 56 etc. In Figure 16 A, a shelf 56 is thus  
20 attached to the structure behind the module by means of a fitting 57 extending through the gap between adjacent modules. In Figure 16 B, the shelf 56 itself extends through the gap and is attached to the wall structure by a fitting comprising for instance a U-shaped portion for insertion of the shelf.

25 Figure 17 illustrates the possibility to utilise a portion of the cavity in a module to accommodate electrical cables, etc. A cavity suitable for this purpose can e. g. be created by insertion of a U-shaped profile 59 into the rear portion of the module, this profile extending over a major portion of the length of the module. Alternatively a number of profiles 59' of limited longitudinal extension could be used.

30

Figure 18 illustrates the possibility to provide the front face of a module with an electrical switch.

Figure 19 illustrates the presence of a loudspeaker in the second plane of a system  
35 of modules according to the invention.

Figure 20 illustrates the possibility to form a module as a sound-radiating device such as a loudspeaker.

- 5     Figures 21 A and B illustrate the placement of a video screen or an access opening for a window etc. in a system of modules, wherein modules of different length are used. As shown the modules can extend both horizontally and vertically, as mentioned previously.
- 10    Returning to the attachment portions of the modules according to the invention, a very simple alternative to the embodiment shown for instance in figure 7 is rendered in Figure 22, this alternative attachment portion lacking the front portion 43 of Figure 7.
- 15    Figure 23 illustrates attachment of a module according to the invention by means of the alternative attachment portion 6 shown in Figure 22. The I-shaped rail shown in a number of the previous Figures is replaced by a U-shaped rail 13, the cross-sectional shape of which is generally indicated by reference numeral 65. The rail is provided with a couple of inwardly extending protrusions 66 for engagement with the
- 20    back plate 50, which - as in Figure 7 - is fixed to the rear portion 42 of the attachment means 6.
- 25    Finally, Figure 24 shows a ninth embodiment of a covering module according to the invention, which can be used for instance when a fabric does not need to be wrapped around the front face and edge portions and fastened by means of the channels 8 described previously.

30    Although various embodiments of the present invention have been shown and described in the preceding parts of the detailed description, it is understood that a person skilled in the art may conceive other embodiments of the invention without departing from the scope of the invention as defined by the following claims.

CLAIMS:

1. A covering module for walls, ceilings and other boundaries comprising a front face (4) on two opposing sides hereof bounded by edge portions (5) for connection of the front face (4) to one or more attachment portions (6, 16), characterised in that each of said edge portions (5) comprises a lateral portion (7) extending at an angle ( $\alpha$ ) relative to said front face (4).
2. A covering module according to claim 1, characterised in that said angle ( $\alpha$ ) is less than 90 degrees.
3. A covering module according to claim 2, characterised in that said angle ( $\alpha$ ) is substantially equal to 45 degrees.
4. A covering module according to claim 1, characterised in that said module furthermore comprises a rear wall (20, 48) opposite said front face (4) and connecting said edge portions (5) on either side of the front face (4), whereby the module attains a closed cross-sectional shape surrounding an internal cavity (19).
5. A covering module according to claim 1, characterised in that said module comprises a solid body of material, the three surfaces of which are said front face (4) and said lateral portions (7).
6. A covering module according to claim 5, characterised in that said material belongs to the group comprising aluminium, plastic, and wood.
7. A covering module according to claim 5, characterised in that said material is a sound-attenuating material.
8. A covering module according to claim 1, characterised in that said module furthermore comprises lateral fastening means in said edge portions (5) for fastening a fabric (24) wrapped around said front face (4) and edge portions (5).
9. A covering module according to claim 8, characterised in that said fastening means comprises a recess or channel (8) in each of said edge portions (5), into

which recess or channel (8) said fabric (24) can be introduced and fixed by means of fastening members (25) corresponding in shape to said recess (8).

5 10. A covering module according to any of the preceding claims, characterised in that said front face (4), said edge portions (5), said attachment portions (6) and said rear wall (20) are formed as one piece.

10 11. A covering module according to any of the preceding claims, characterised in that said edge portions are also provided at the longitudinal ends of said front face (4).

12. A covering module according to claim 1, characterised in that said front face (4) is a separate panel attached to said edge portions (5).

15 13. A covering module according to claim 1, characterised in that said attachment portions (6) extend (56) over substantially the complete length of the module.

20 14. A covering module according to claim 12, characterised in that the attachment portions (16) of each of the opposing edge portions exhibit mirror-symmetry about a plane (Z) perpendicular to the front face (4).

25 15. A covering module according to claim 1, characterised in that said edge portions (5) are provided with engagement portions (8', 8'', 47; 11', 11'', 40) for releasable engagement with said attachment portions (6, 16).

30 16. A covering module according to claim 15, characterised in that said attachment portion (6, 16) comprises a substantially rigid base section (41, 42, 43) for attachment to a rail (13) or equivalent means, and furthermore comprises laterally resilient side portions (46) for releasable engagement with said engagement portions (8', 8'', 47; 11', 11'', 40) in the module.

17. A covering module according to claim 8, characterised in that said front face (4) is provided with a fabric (24).

18. A covering module according to claim 1, characterised in that said front face (4) is provided with veneer or tape.
19. A covering module according to claim 1, characterised in that at least a portion  
5 of said front face (4) is provided with a frontal recess (27).
20. A covering module according to claim 19, characterised in that said frontal recess (27) is filled with a sound-attenuating material (27).
- 10 21. A covering module according to claim 4 or 10, characterised in that said front face (4) or a back wall (28) of said recess (27) is provided with a pattern of openings (29) for communication with said internal cavity (19).
- 15 22. A covering module according to claim 18, characterised in that said internal cavity (19) is partly or completely filled with a sound-attenuating material (26).
23. A covering module according to claim 4 or 10, characterised in that said front face (4) or a back wall (28) of said recess (27) is provided with at least one channel (31) for communication with said internal cavity (19), where the acoustical mass of  
20 said channel (31) and the acoustical compliance of said cavity (19) are chosen to provide an acoustical damping element of the Helmholtz resonator type.
24. A flexible covering system for walls, ceilings and other boundaries comprising a plurality of rails or equivalent means (13) for attachment to a wall structure, a ceiling  
25 or the like (14), characterised in that said system comprises a number N of planes P1, P2 ..... at a predetermined distance from said wall structure (14), where N = 1, 2 ....., where P1 corresponds to the plane at the greatest distance from the wall structure (14), these planes containing modules (1, 2, 3, 4) according to any of the preceding claims, and where the attachment portions (6, 16) of said modules (1, 2,  
30 3, 4) in a given plane Pi can be brought into releasable engagement with said rails (13) at any desired position along the rails (13).
25. A flexible covering system according to claim 24, characterised in that the attachment portions (6, 16) of said modules (1, 2, 3, 4) in a given plane Pi can be  
35 brought into releasable engagement with said rails (13) at any desired position along

the rails (13) through passages between the edge portions (5) of adjacent modules of planes  $P_{i+1}$ ,  $P_{i+2}$ , .... closer to said rails (13).

5 26. A flexible covering system according to claim 24, characterised in that the system comprises modules of different length.

27. A flexible covering system according to claim 24, characterised in that modules of different planes  $P_i$  are attached to separate systems of rails (13).

10 28. A flexible covering system according to claim 24, characterised in that said planes  $P_1$ ,  $P_2$  .... are running substantially parallel to the wall structure (14).

29. A flexible covering system according to any of the preceding claims 24 to 28, characterised in that passages (32) are provided between said edge portions of at  
15 least some of said modules (1, 2, 3, 4) in a given plane  $P_i$  for providing access to modules (1, 2, 3, 4) in the adjacent plane  $P_{i+1}$ .

30. A flexible covering system according to claim 29, characterised in that  $N = 2$ .

20 31. A flexible covering system according to claim 30, characterised in that the modules in the first plane  $P_1$  are of the first kind according to any of the claims 1 to 24 with the exception of claim 5, 6 or 7, and that the modules in the second plane  $P_2$  are of the second kind according to any of the claims 5, 6 or 7.

25 32. A flexible covering system comprising modules according to any of the preceding claims 24 to 31, characterised in that said system furthermore comprises intermediate members (10) formed for displacement along said rails (13) and for releasable engagement with said attachment means provided on said modules (1, 2, 3, 4).

30 33. A flexible covering system according to any of the preceding claims 24 to 29, characterised in that said modules (1, 2, 3, 4) in any given plane  $P_i$  are attached to two rails (13) of said plurality of rails.

34. A flexible covering system according to claim 24, characterised in that said plurality of rails (13) extend substantially horizontally.

5 35. A flexible covering system according to claim 24, characterised in that said plurality of rails (13) extend substantially vertically.

36. A flexible covering system according to claim 30 or 31, characterised in that the modules in the second plane extend over the entire distance between the attachment portions (6, 16) of adjacent modules in the first plane.

10

37. A flexible covering system according to claim 24, characterised in that at least one passage (35) is provided between modules of each of said planes, allowing a flow of air (36) through said at least one passage (35) from a region at the wall structure (14) through the one or more planes  $P_i$  to the surroundings.

15

38. A flexible covering system according to claim 24, characterised in that adjacent modules in said first plane  $P_1$  are placed substantially in contact with each other along said edge portions (5) of the modules.

20 39. The use of modules according to any of the preceding claims 1 to 23 for attaining desirable acoustical characteristics of a room or predetermined portions of a room.

25 40. The use of modules according to claim 39, characterised in that the modules are attached to movable partitions for subdividing a room into smaller compartments.

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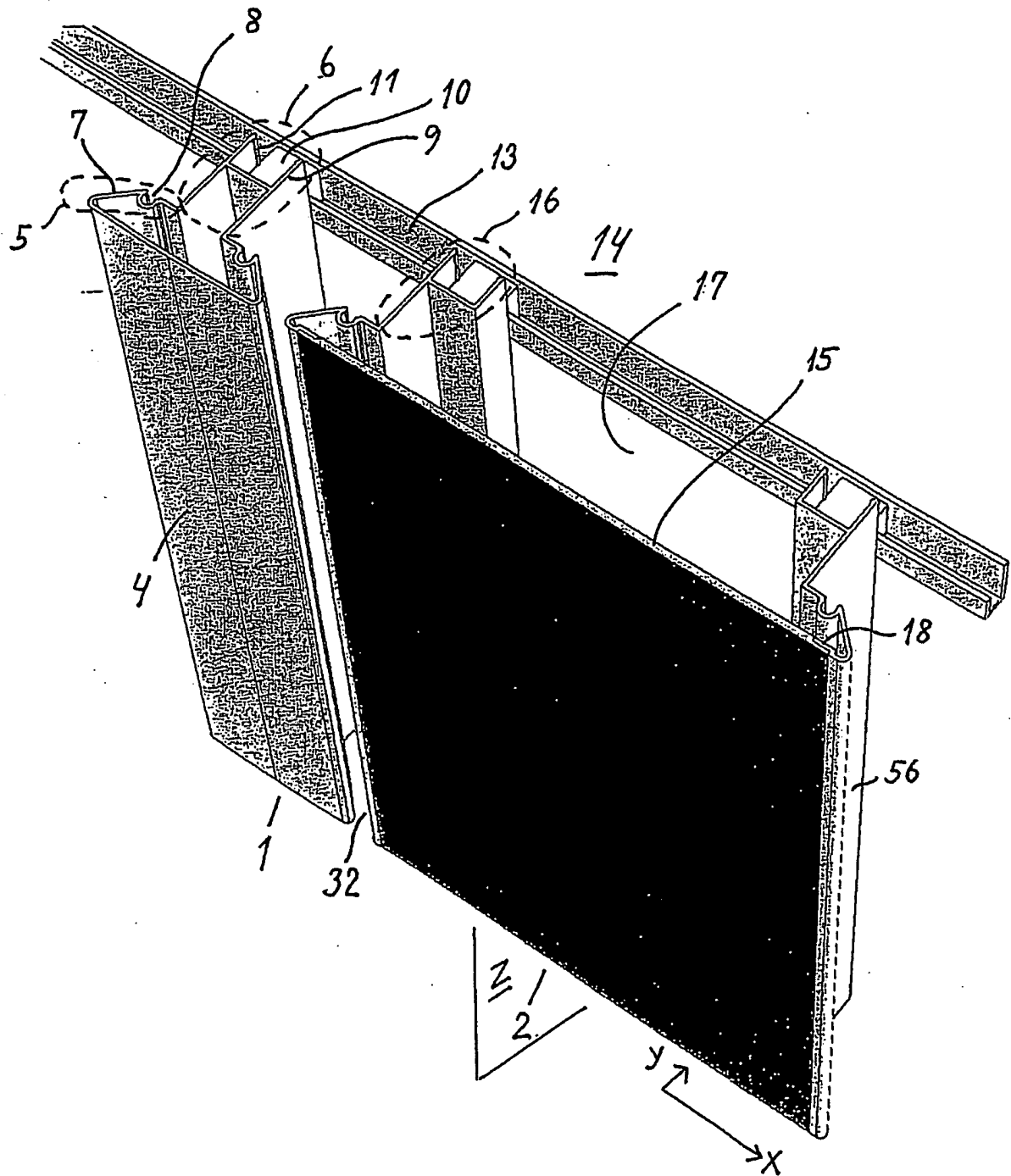


Fig. 1

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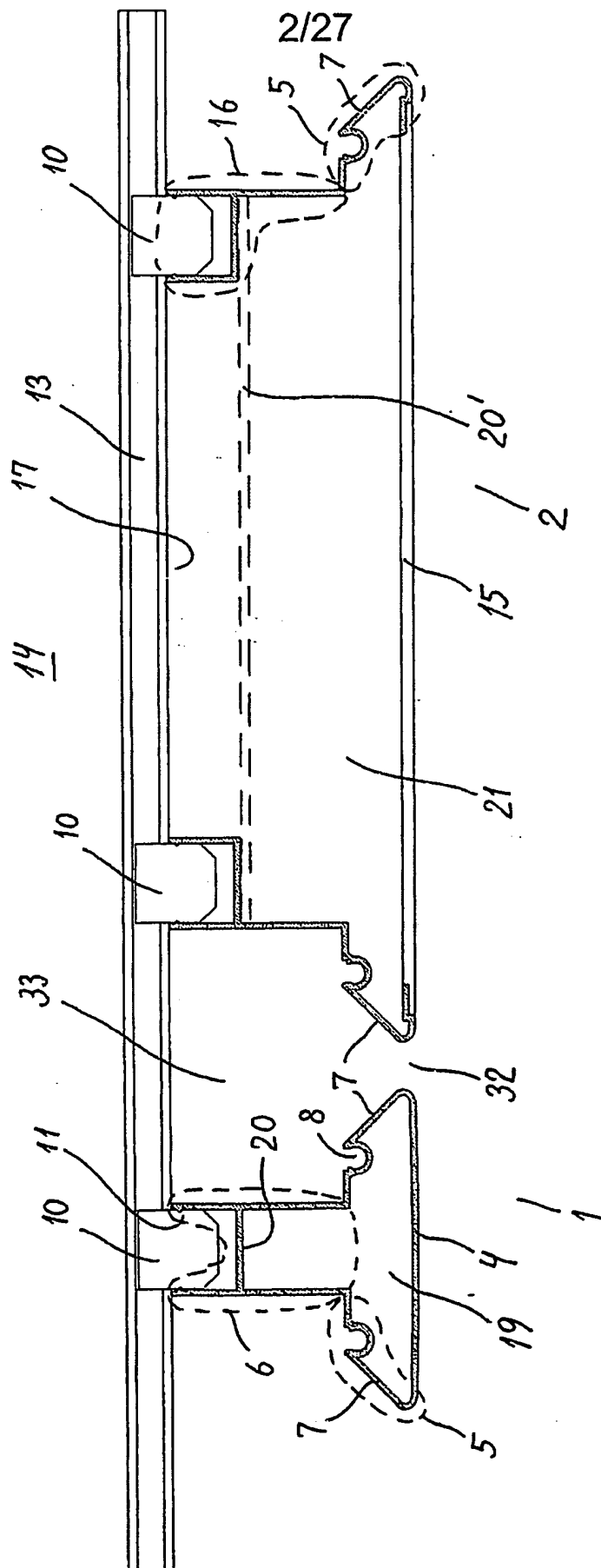


Fig. 2

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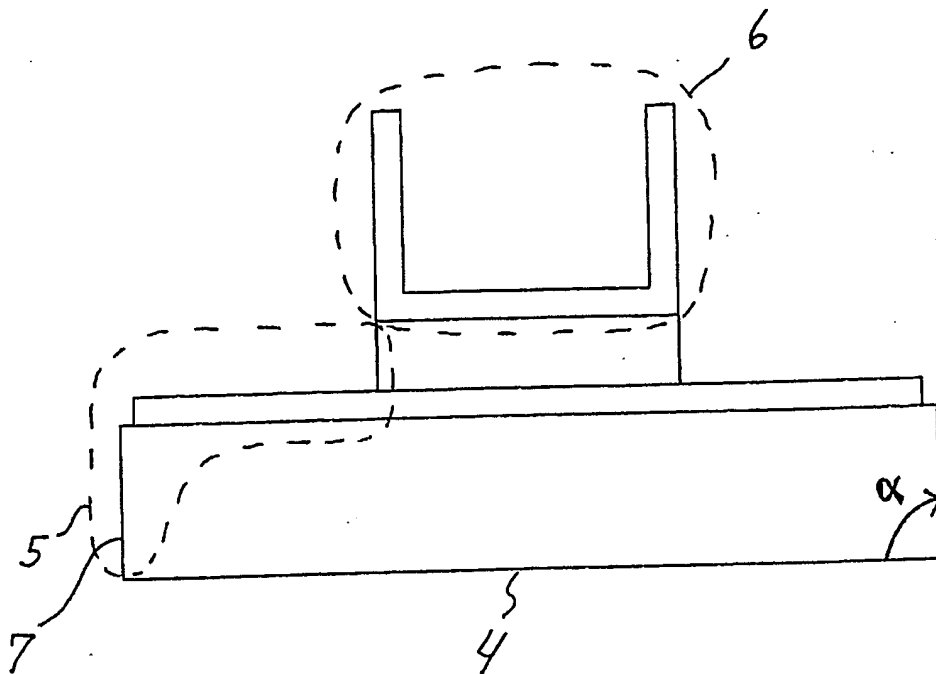
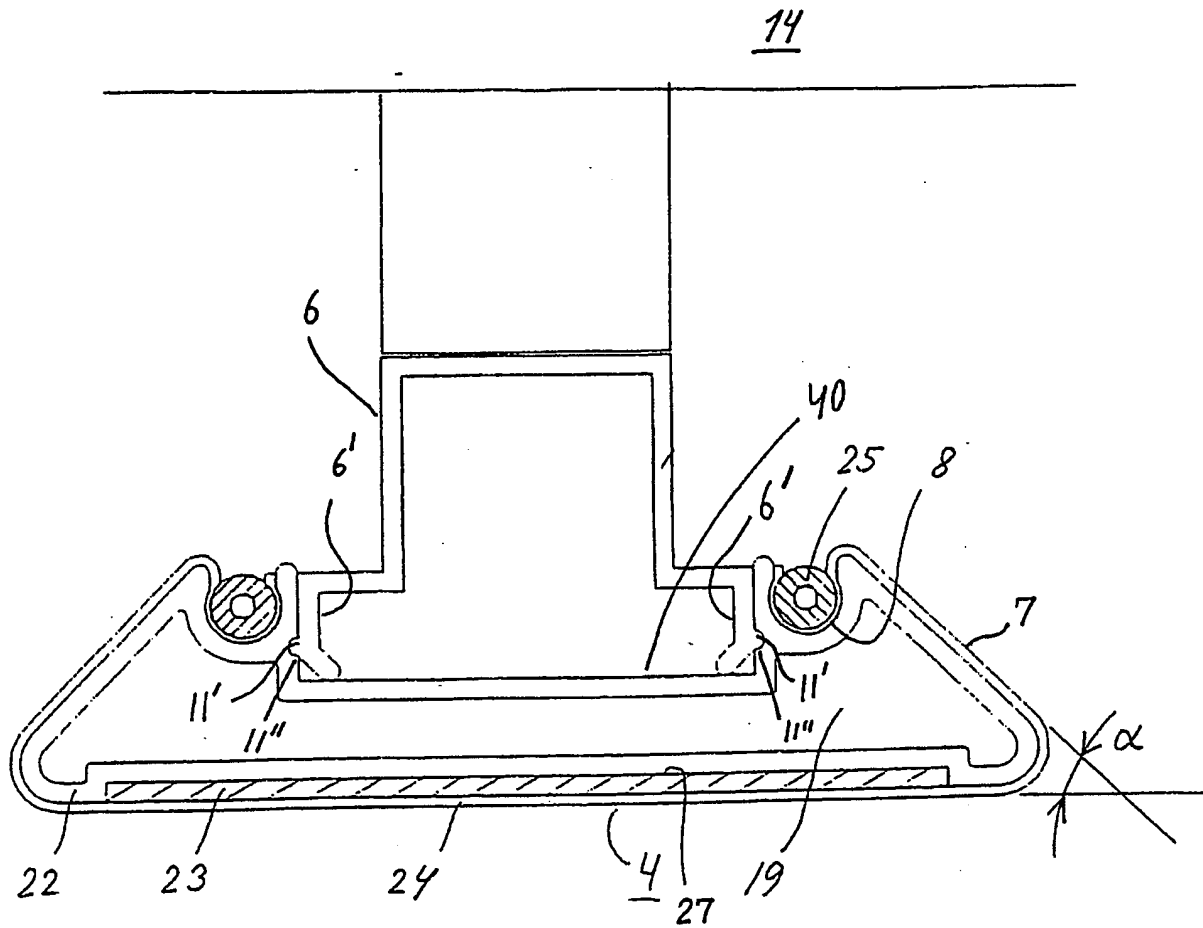


Fig. 3

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**Fig. 4**

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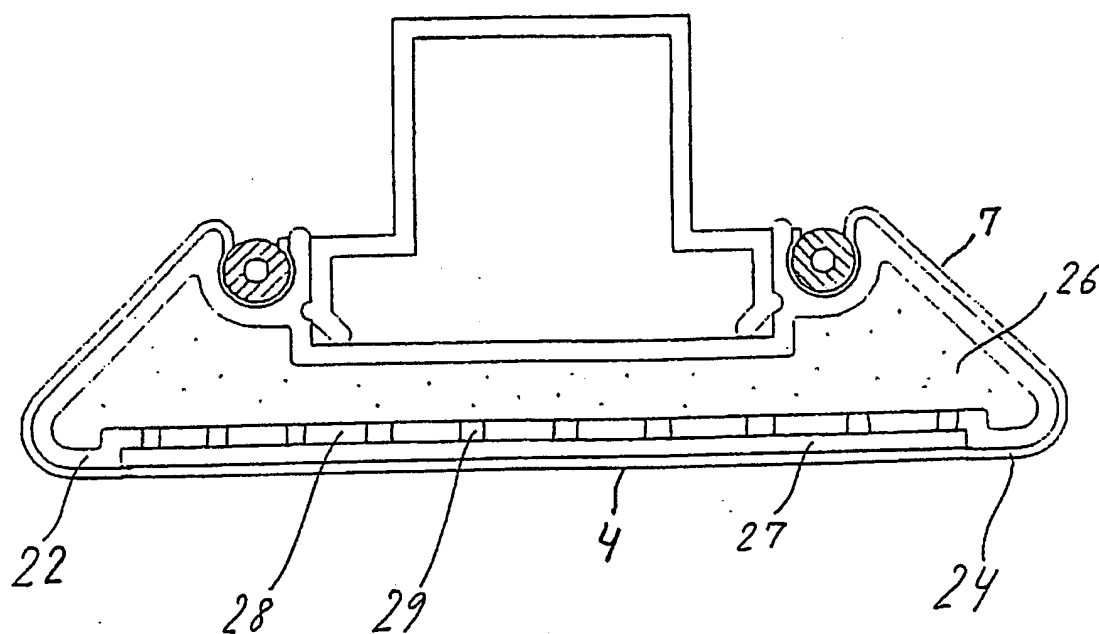


Fig. 5

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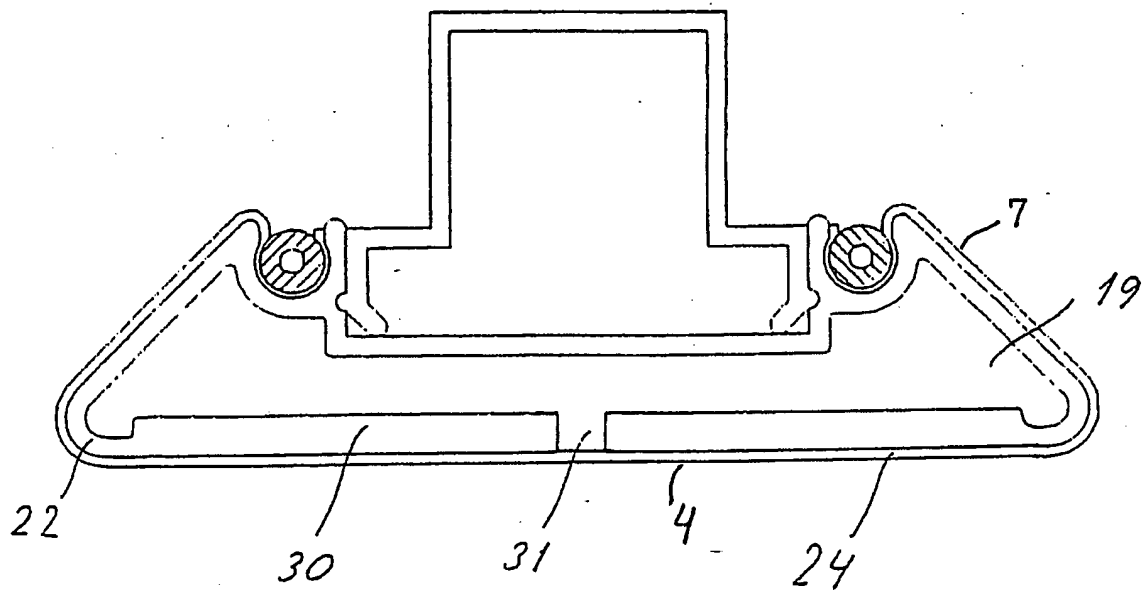


Fig. 6



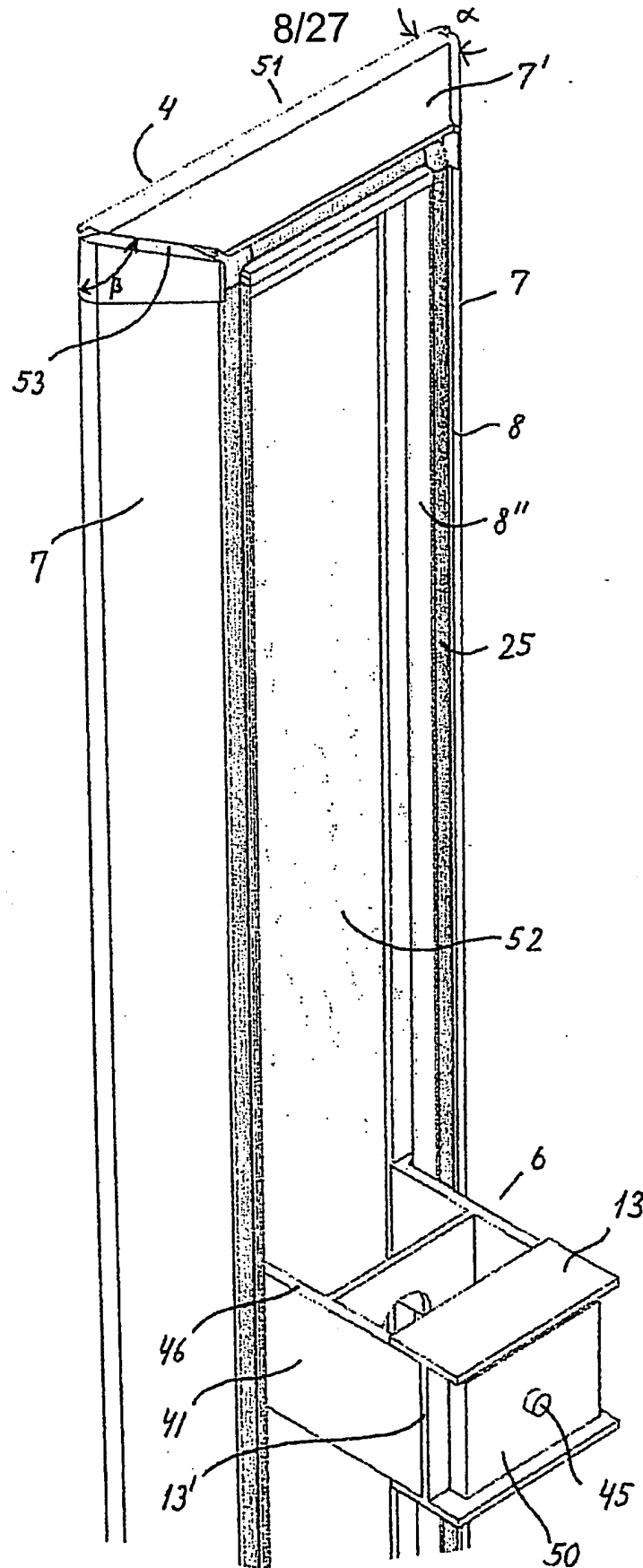


Fig. 8

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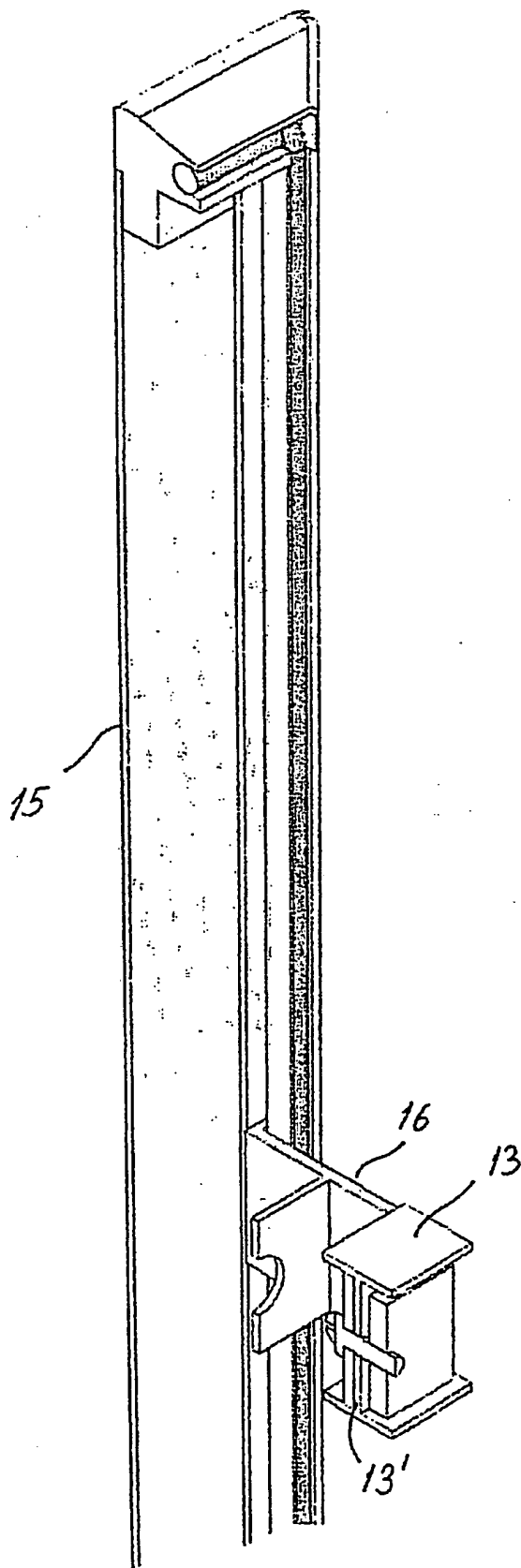


Fig. 9

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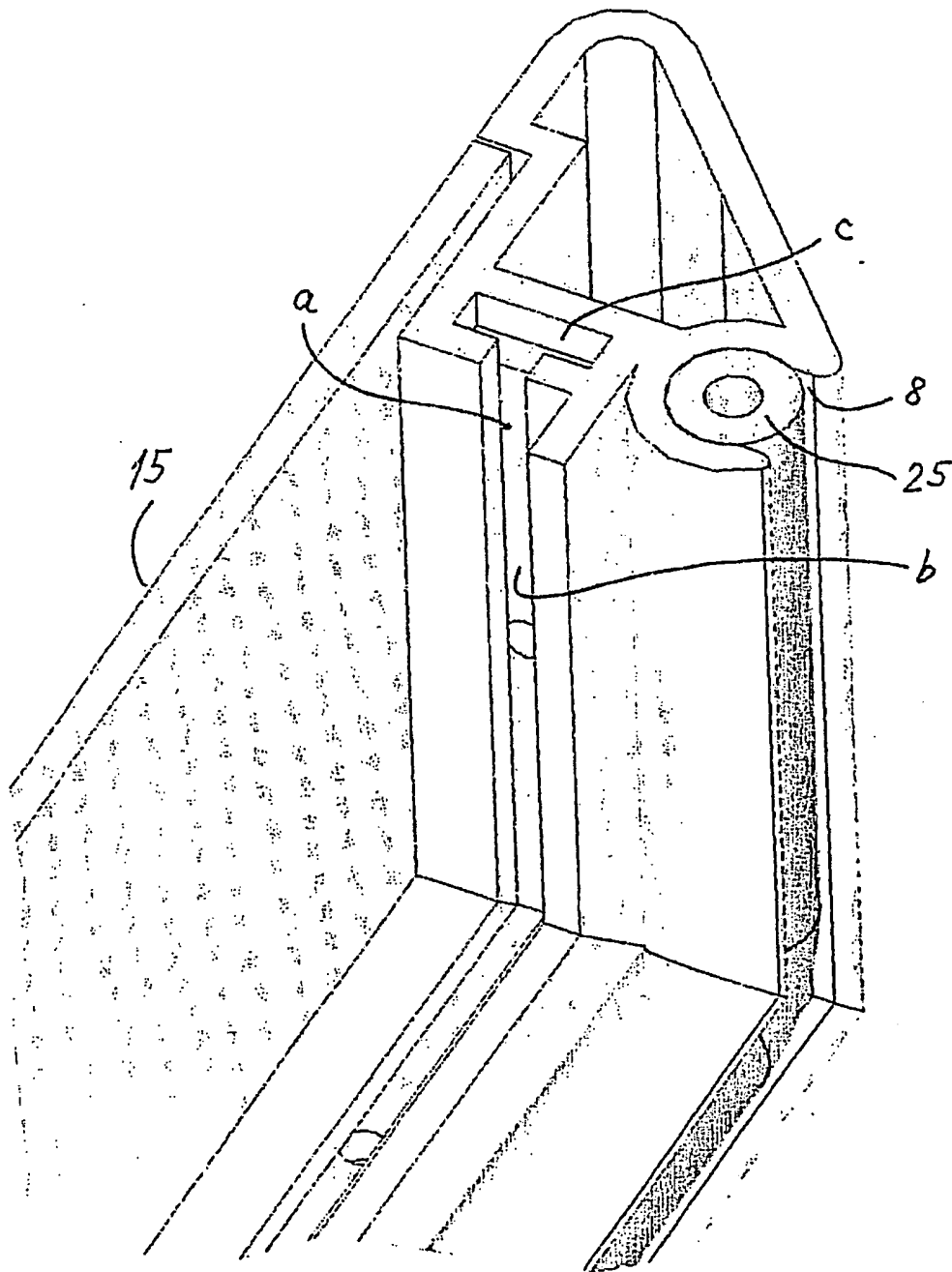
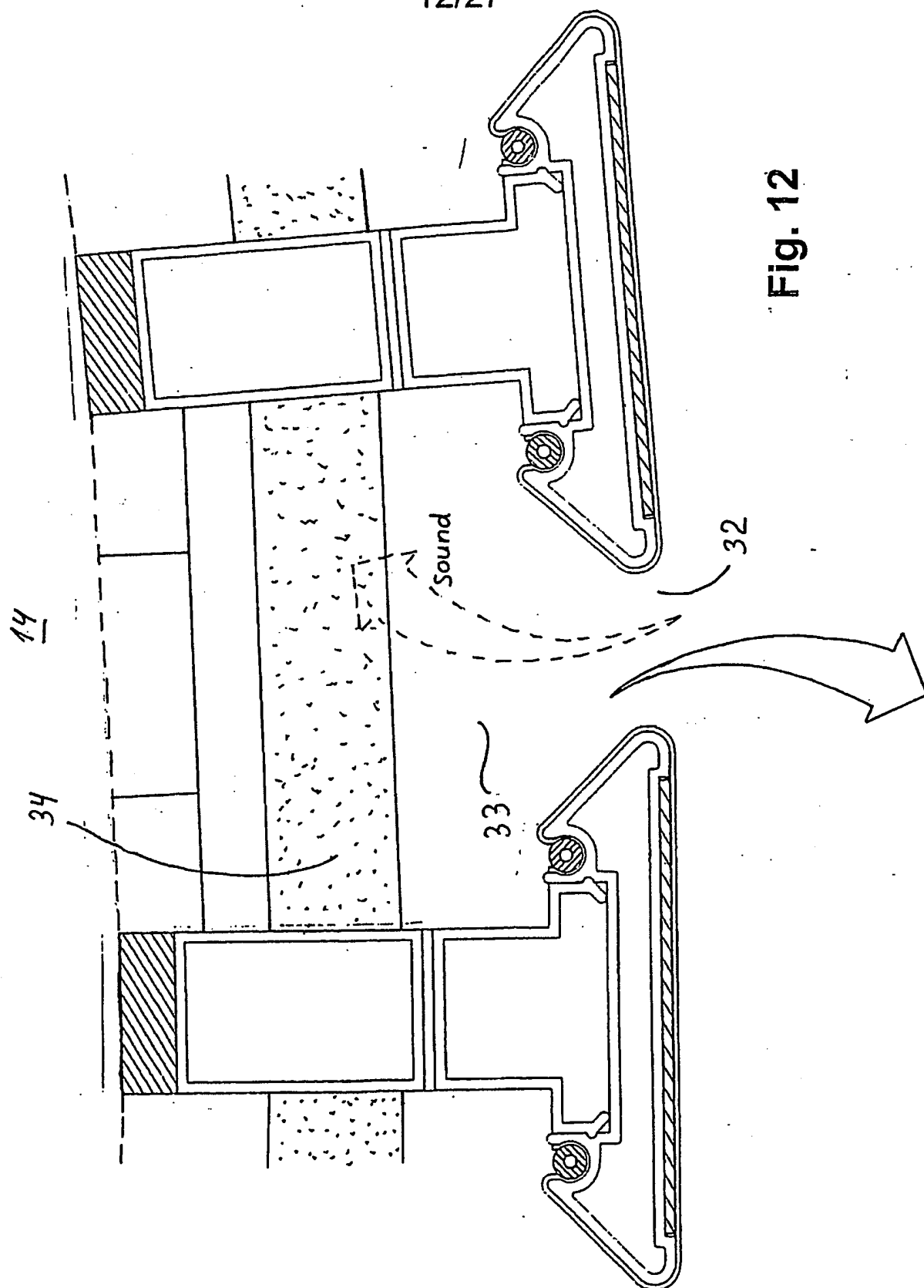


Fig. 10



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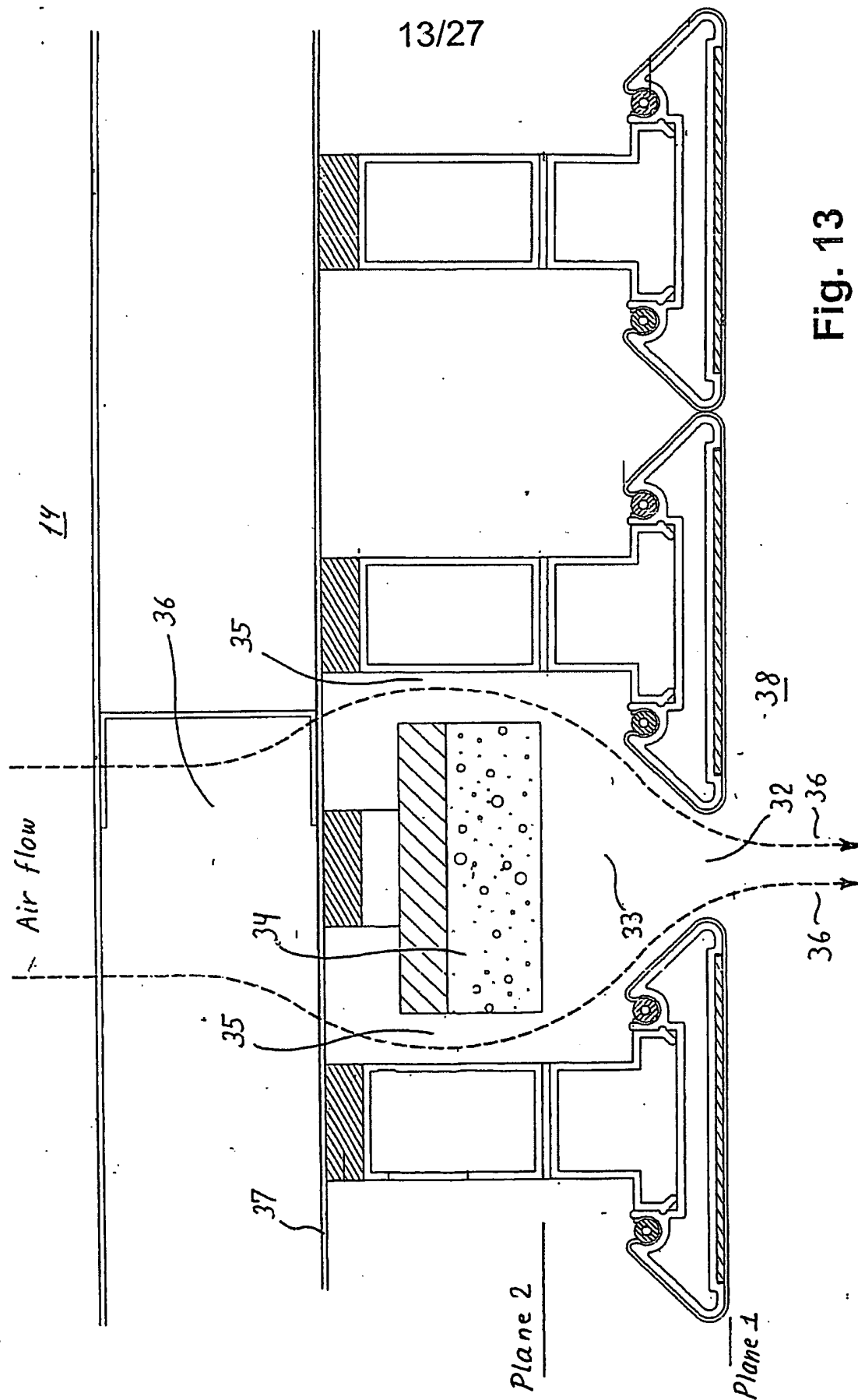


Fig. 13

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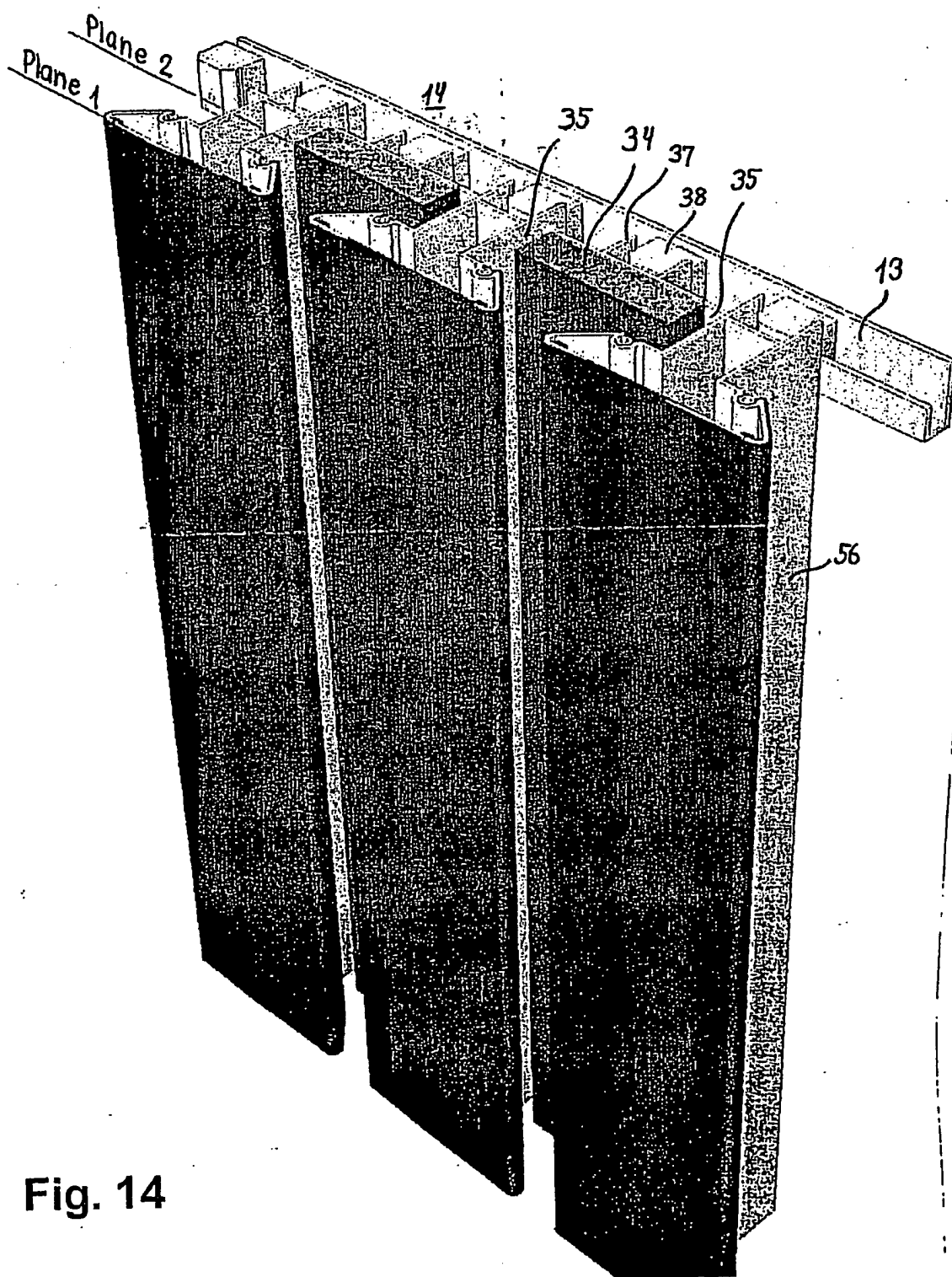


Fig. 14

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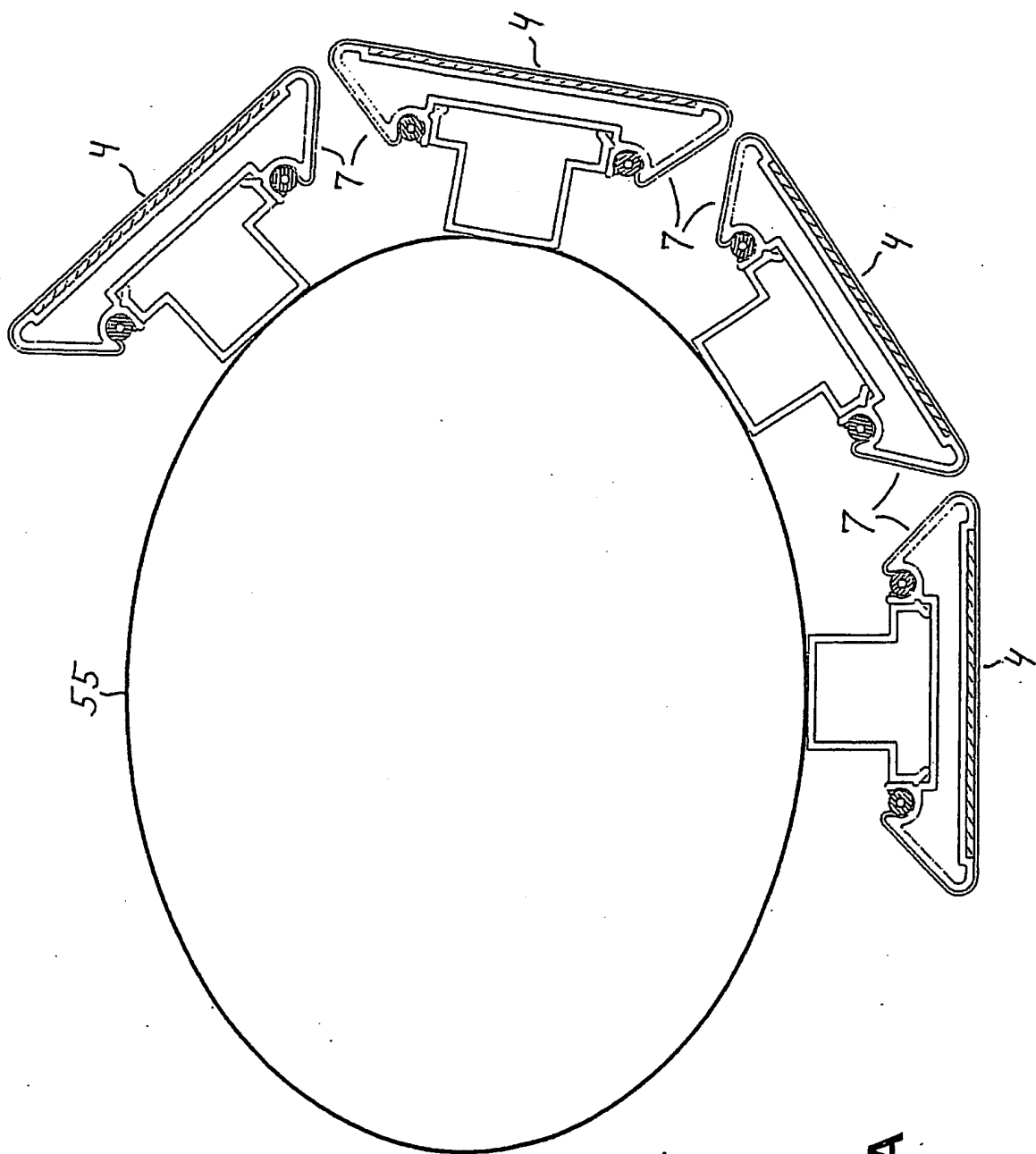


Fig. 15 A

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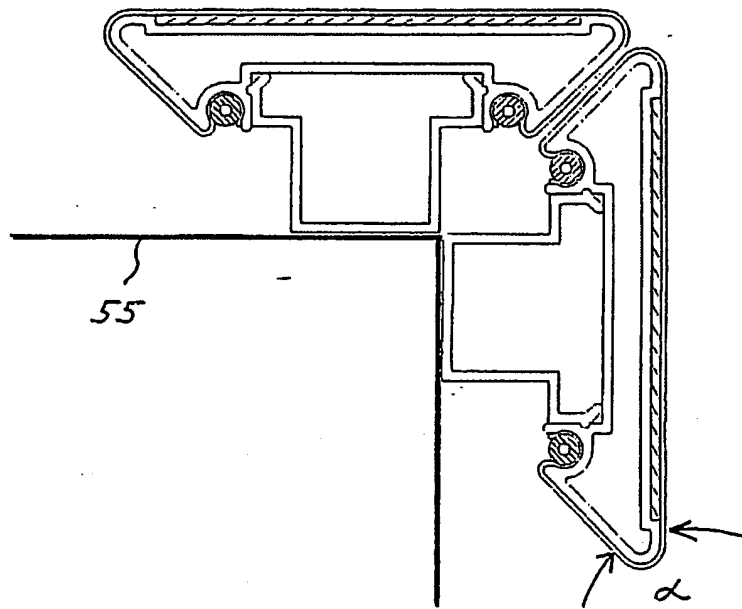


Fig. 15 B

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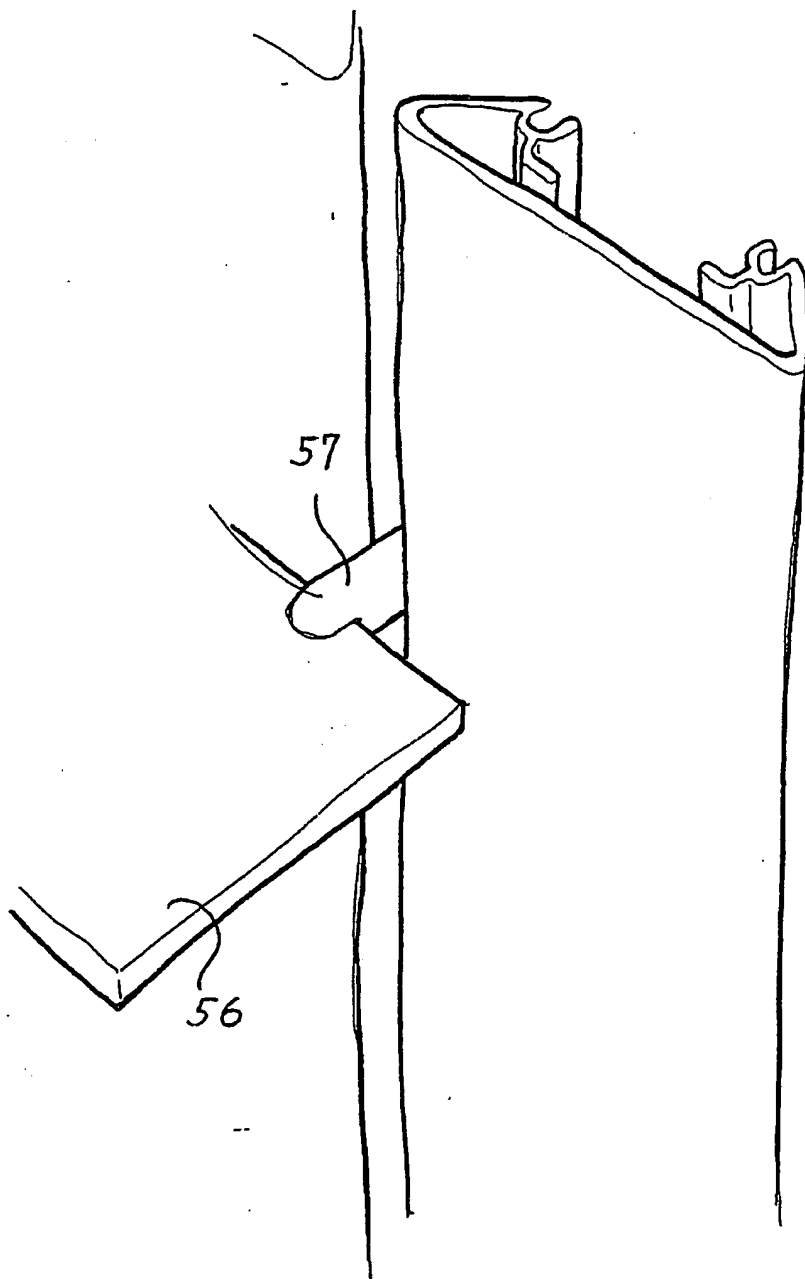


Fig 16A

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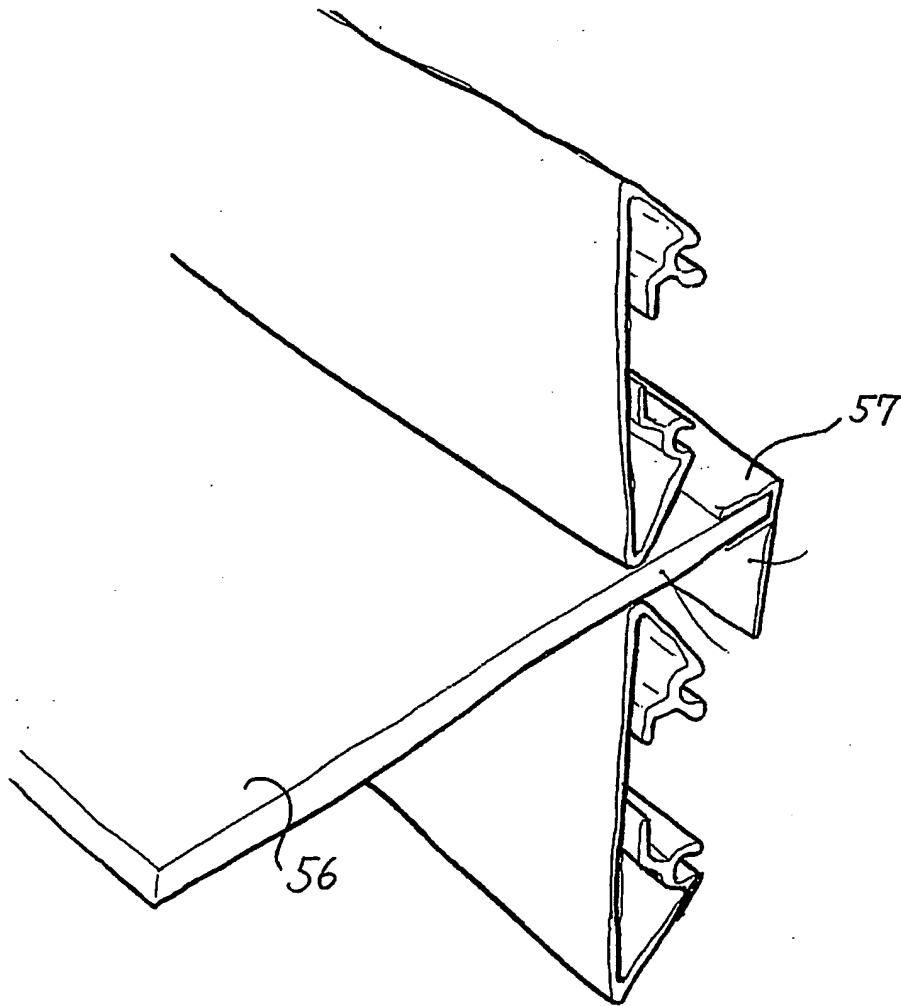


Fig 16B

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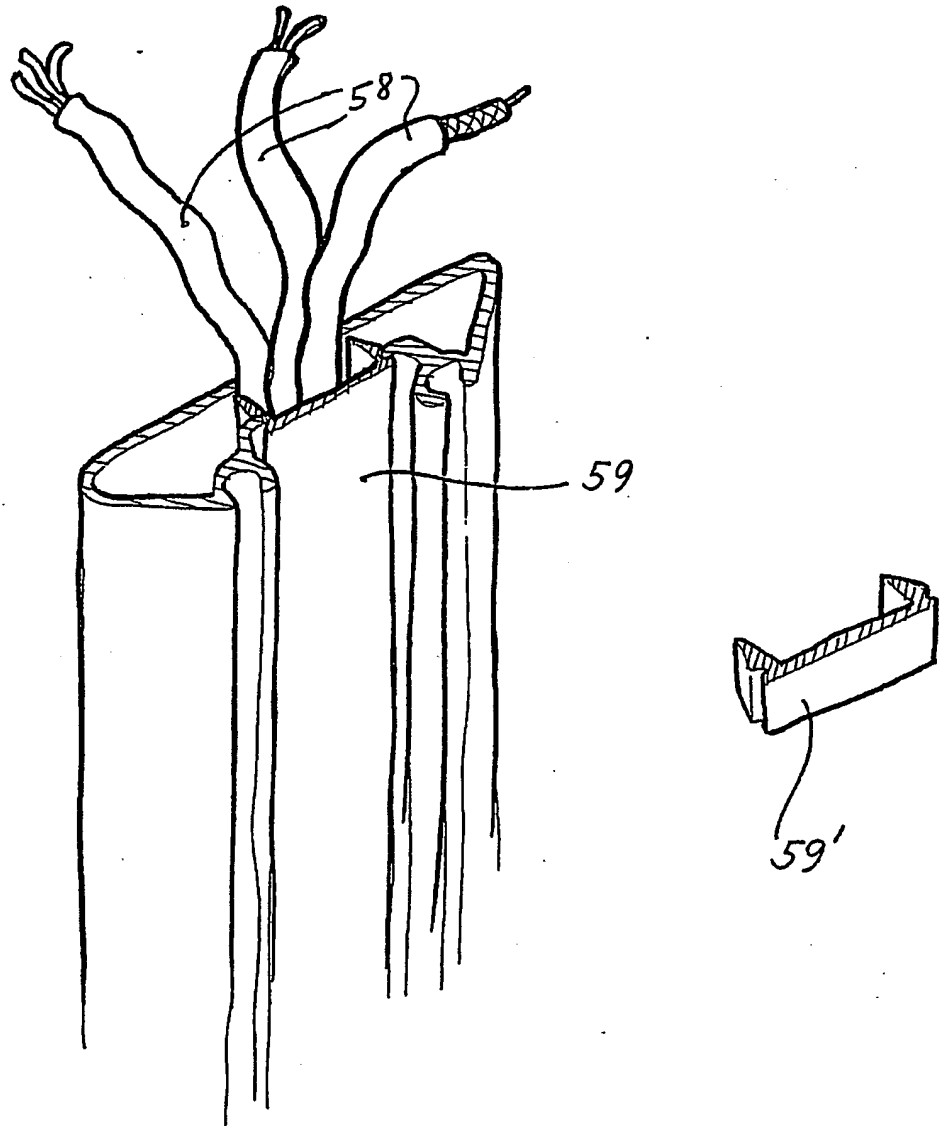


Fig 17

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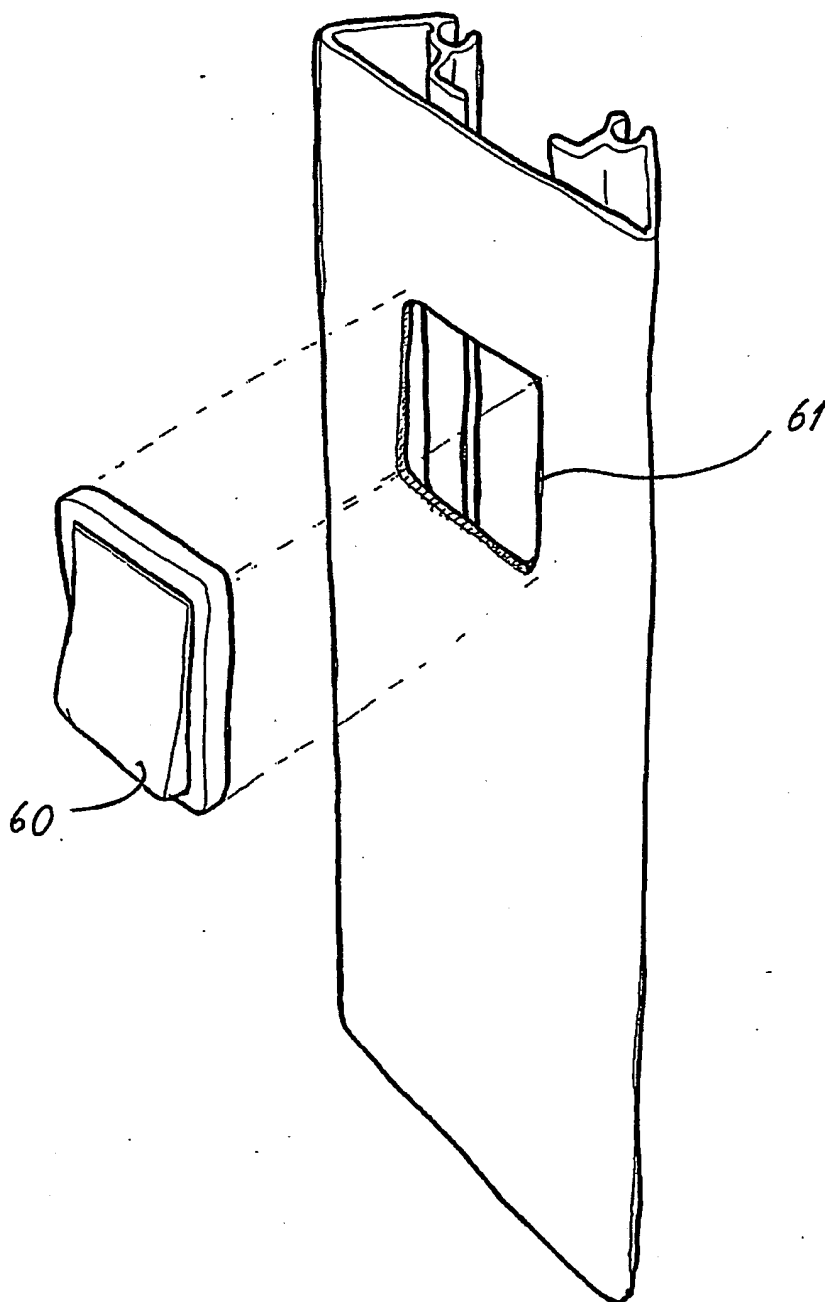


Fig 18

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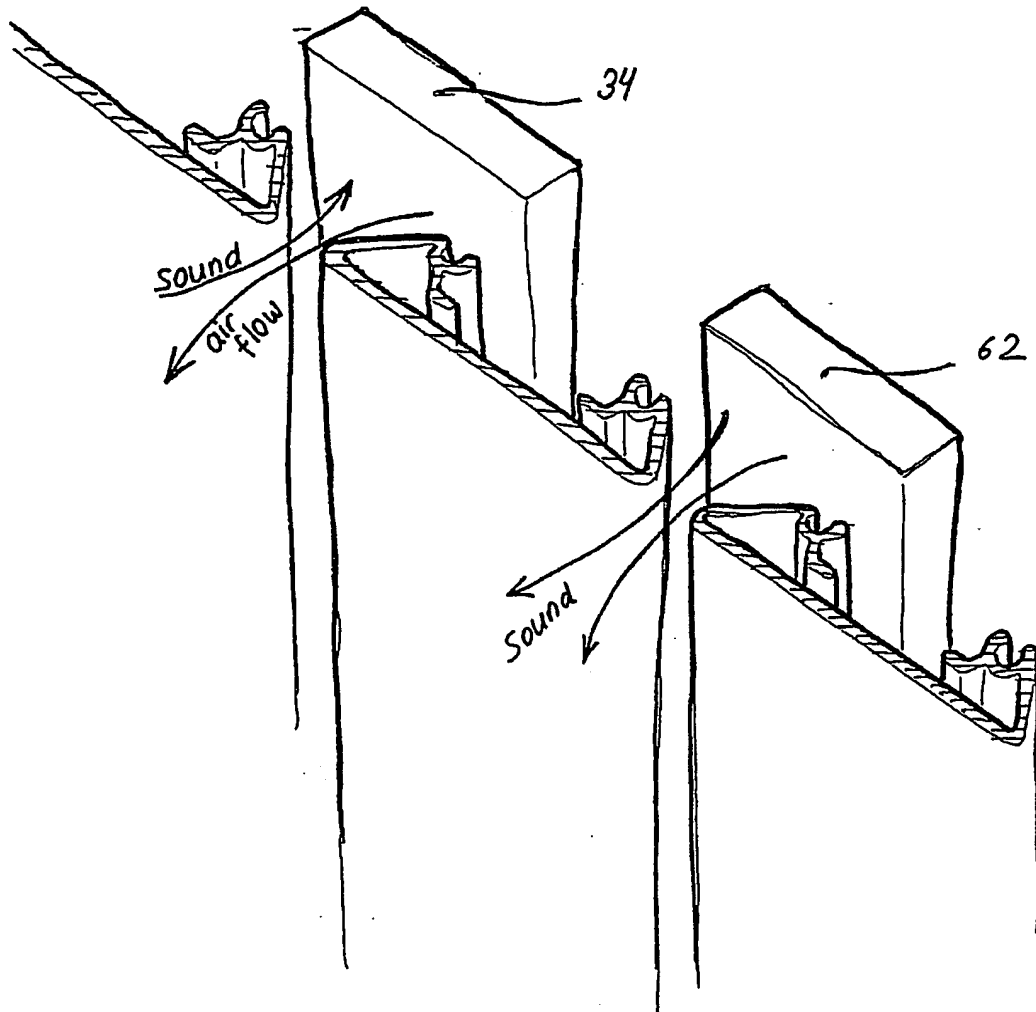
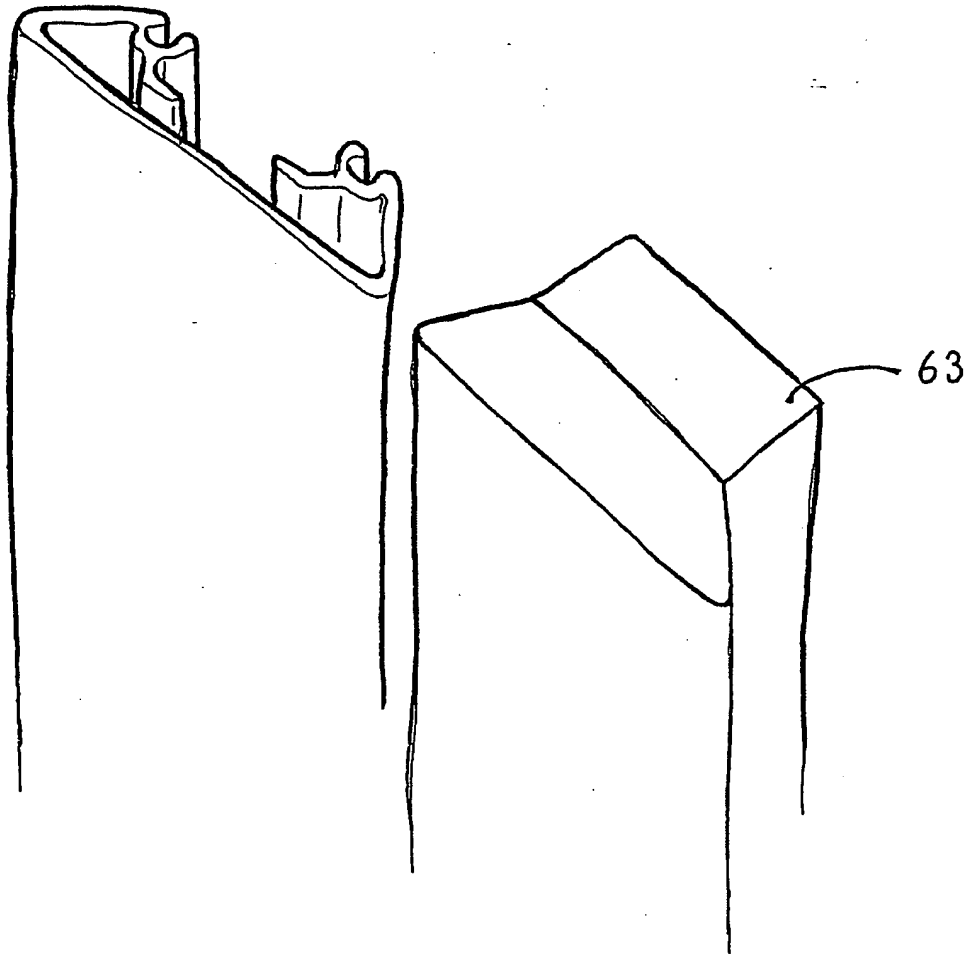


Fig 19

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**Fig 20**

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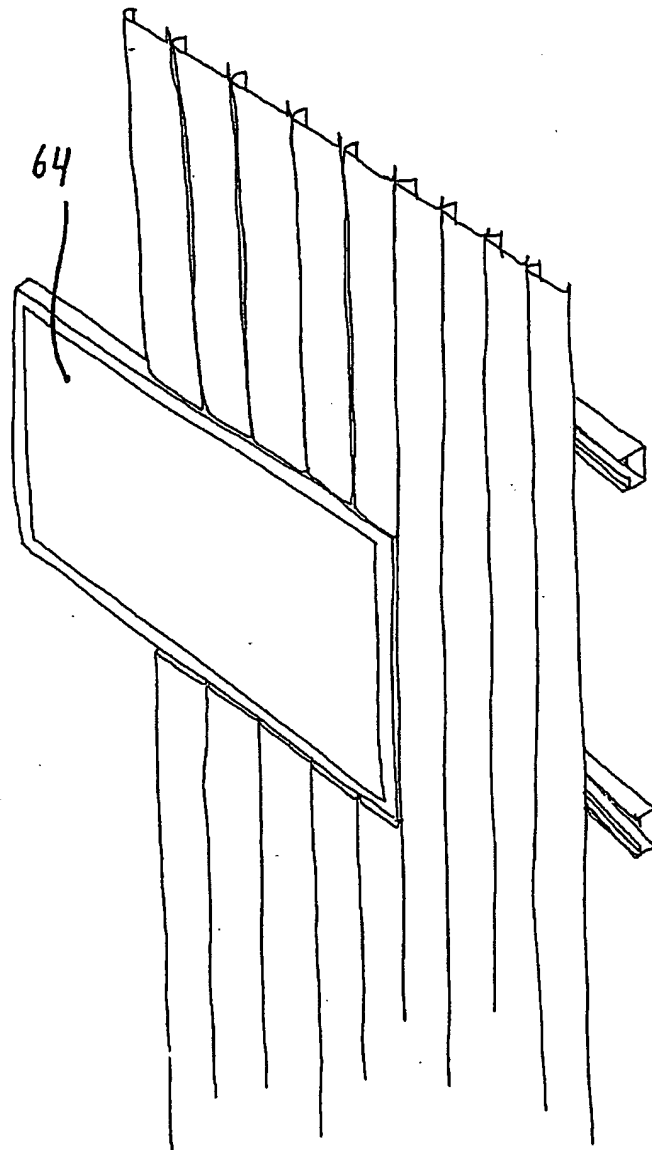


Fig 21A

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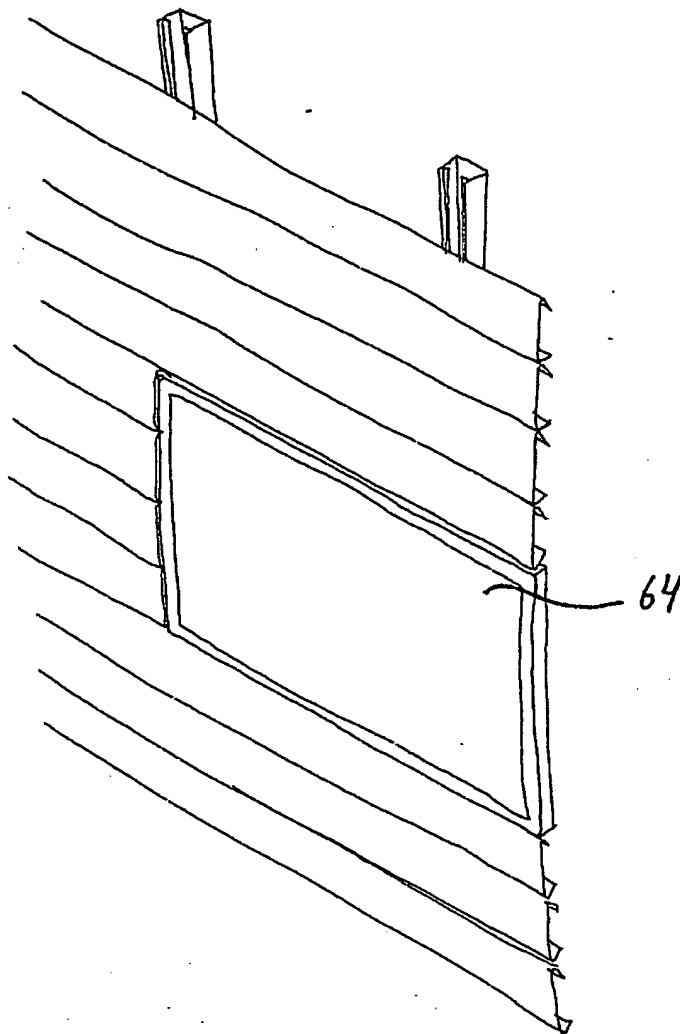


Fig 21B

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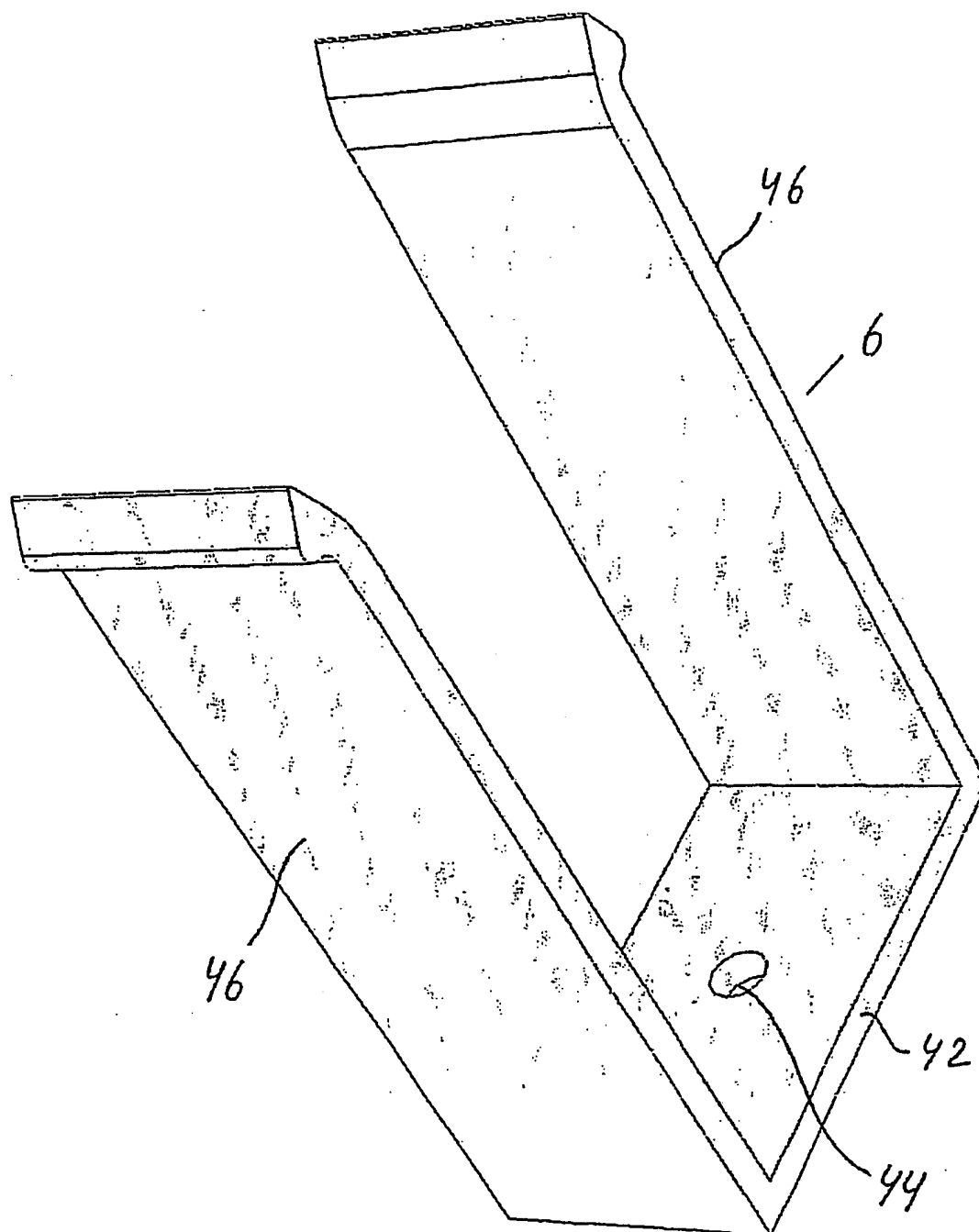


Fig. 22

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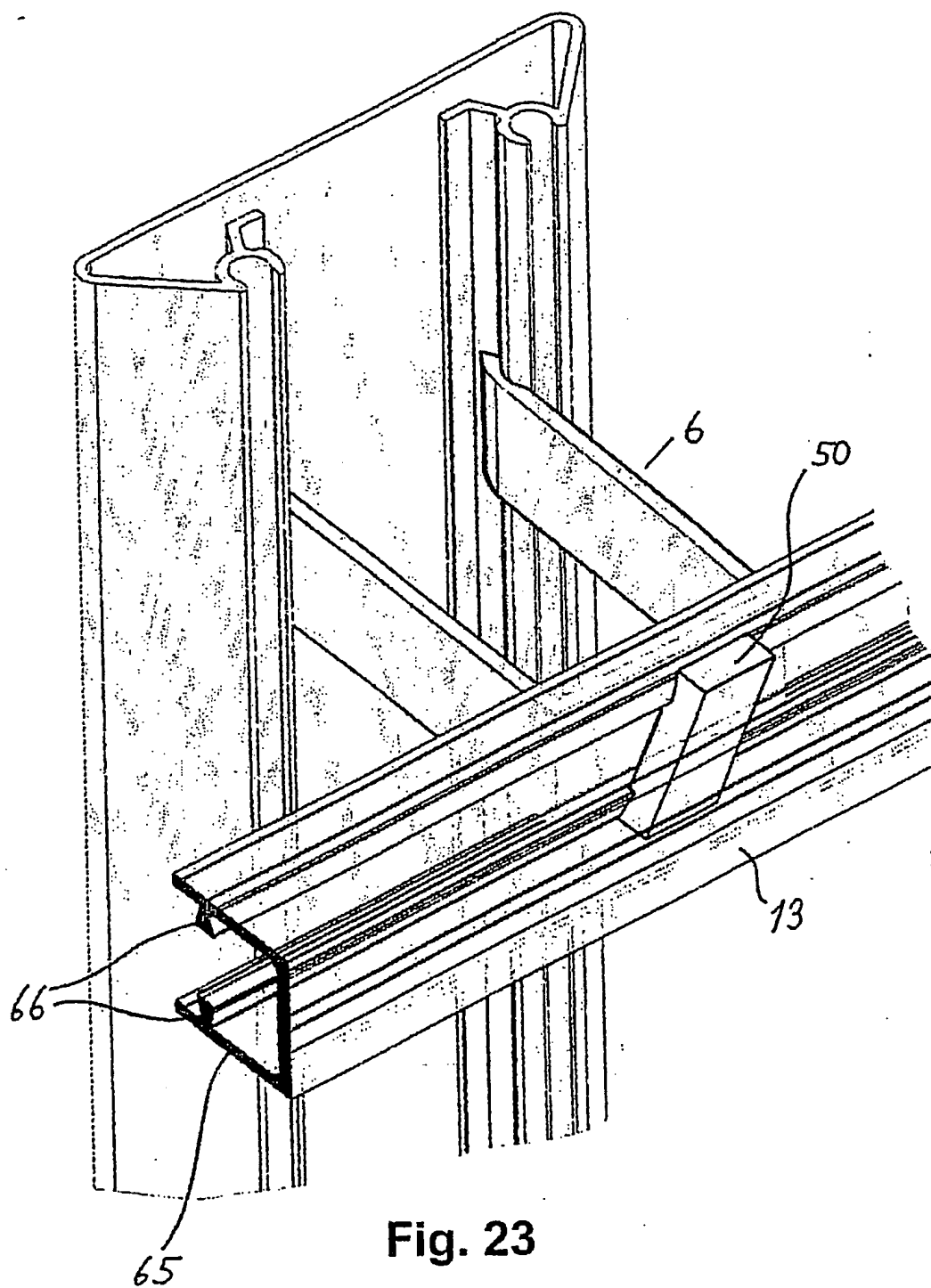


Fig. 23

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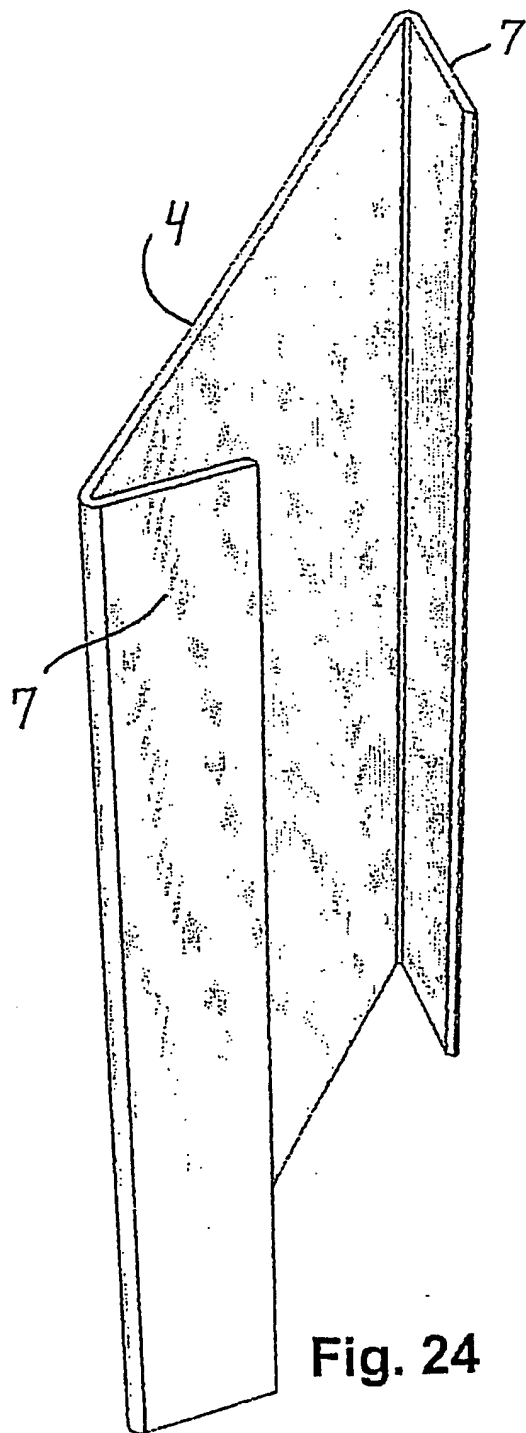


Fig. 24

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/DK 03/00357

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E04F13/08 E04B9/04 E04B1/82 E04C2/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E04F E04B E04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex

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Date of the actual completion of the international search

19 November 2003

Date of mailing of the international search report

11.12.2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/DK 03/00357

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4 640 064 A (GOODWORTH II JOHN P) 3 February 1987 (1987-02-03)  abstract; figures 3,4	1,5,6, 11,13, 15,21,22
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Information on patent family members

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